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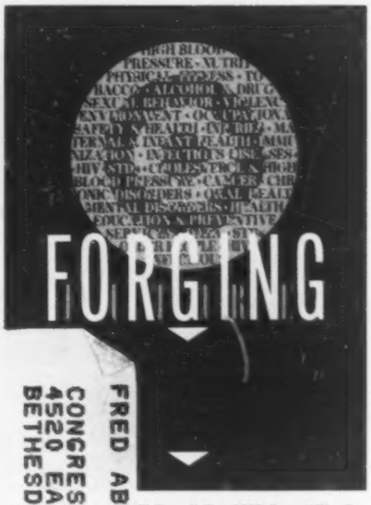

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Meeting the Needs for Health Services of Persons with Mental Retardation Living in the Community

PAULA M. MINIHAN, MSW, MPH, AND DEBORAH H. DEAN, MSPH

Abstract: Adequate health services are critical to the success of efforts to maintain persons with mental retardation in the community, yet information concerning the health status of this population is in short supply. This paper presents the results of a survey of 333 mentally retarded persons randomly selected from a population of 1,333 such individuals living in community settings. Almost two-thirds had chronic conditions requiring medical intervention. The top five conditions in terms of prevalence were neurologic, ophthalmologic, dermatologic, psychiatric-emotional, and orthopedic. The majority of conditions were being managed appropriately in the community health system. A substantial proportion can be managed by primary care physicians with limited specialty involvement. For almost 60 percent of clients with conditions requiring home treatments on an ongoing basis, however, service gaps were identified. Other problems included the reluctance of some providers to accept Medicaid, and the inability of some clients to cooperate with medical examinations. (*Am J Public Health* 1990; 80:1043–1048.)

Introduction

Adults and children with mental retardation have the same needs as other individuals for preventive health care, episodic care for acute illness, and ongoing care for chronic medical conditions. They often have chronic conditions, physical disabilities, and sensory deficits that are associated with their mental retardation and require specialized services. Some may have acquired conditions, e.g. contractures, related to suboptimal medical management.[1]

Ensuring adequate health services to manage these needs is critical to the success of efforts to maintain persons with mental retardation in the community, yet information concerning the population living in community settings and their requirements for health services is in short supply. The decentralized nature of the community system and the variety of living arrangements which it supports—ranging from sheltered housing with on-site supervision to assistance to persons living with their families or living independently—make it difficult to conduct survey research which depicts the overall population.

National data are available which describe the population living in staffed residential facilities in the community.[2] Comparable data describing retarded persons living with their families or living independently are not available although this is a larger population.

Published studies of the health needs of persons with mental retardation living in community settings report that these individuals have significant health problems,[3-5] but they may be biased toward individuals with the most complex medical conditions. None are based on the experiences of randomly selected subjects, a factor which is of concern given the heterogeneous nature of this population. Two of the published studies are also based on the experiences of a limited number of subjects, most of whom had been previously institutionalized, a factor generally associated with a poorer health status.

Studies of the prevalence of medical conditions among mentally retarded persons living in institutions also report that these individuals carry a burden of chronic disease which is greater than that in the general population.[6-8] Studies describing the health status of institutionalized populations, however, may not be applicable to the population living in the community, particularly to those who have never been institutionalized.

The present study sought to eliminate these potential sources of bias by surveying the health needs of a large sample randomly selected from a population of persons with mental retardation living in a range of settings in the community. Only one-third had been institutionalized previously. Information is provided concerning the prevalence of chronic conditions among these individuals and their concomitant requirements for physician, allied health, and home health services.

Methods

Sample

The study population universe was composed of 1,333 individuals with mental retardation who were receiving services in the community system administered by the Massachusetts Department of Mental Health/Division of Mental Retardation in southeastern Massachusetts. All clients were receiving active case management services and most were receiving additional services including residential and day program services. A sample of 350, stratified by area, was randomly selected for study. Seventeen individuals who did not meet eligibility criteria were excluded: seven lived in other regions, eight had withdrawn their request for services, one was determined not to be mentally retarded, and one was living in a public institution. The final sample consisted of 333 clients.

Data Collection

Data were collected by a client-specific questionnaire that was completed for each client by his or her designated service coordinator. The survey covered a 12-month period. Following training sessions supplemented by a reference manual, the questionnaire was completed primarily from the clients' record which includes their individual service plans. Regulations require a medical assessment for each client soon after the initiation of services and reviewed annually thereafter, and an annual medical assessment that includes a physical examination with a gynecological examination for women. The record also contains the service coordinator's quarterly progress notes which document events relevant to

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Address reprint requests to Paula M. Minihan, MSW, MPH, Instructor, Department of Community Health, Tufts University School of Medicine, 136 Harrison Avenue, Boston, MA 02111. Ms. Dean is Research Associate in that same department. This paper submitted to the Journal July 7, 1989, was revised and accepted for publication March 15, 1990.

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the client's major health and other service needs. If the information requested in the questionnaire was not available in the record, the client's program staff or family was contacted to obtain it. Completed questionnaires were obtained for all of the 333 clients in the sample.

Data concerning the prevalence of chronic conditions were validated as follows: a 16 percent random sample was selected from the group who had been institutionalized. Their medical records in the institution were reviewed and compared with the information in this survey. In addition, for seven clients, medical assessments had been completed by their physicians 18 months earlier in another survey conducted by these authors;[7] this information was similarly compared with the survey information.

Data Analysis

Data related to clients' background, demographic characteristics, extent of need for health services, and health service utilization were analyzed using the Statistical Package for the Social Sciences (SPSS). Responses to open-ended questions were content analyzed according to pre-selected categories. In order to determine the adequacy of service utilization, several measures were taken. The project's advisory committee, an interdisciplinary group of professionals with expertise relative to mental retardation, delineated the constellation of physician and home health services that should be available to mentally retarded persons in the community. The services received by a client were judged to be adequate if the client was being seen by the appropriate type of provider given the nature and severity (i.e. level) of the client's medical condition. The analysis of physician services involved an additional step: a physician review panel—composed of an internist/family practitioner in private practice, a family practitioner in a community health center, and an internist practicing in a state residential facility for the mentally retarded—reviewed the client's medical conditions and noted if the current provider was adequate.

Determining Need for Physician and Allied Health Services—The project's advisory committee decided that each client should have an age-appropriate primary care physician (internists for adults, pediatricians for children, family practitioners for either). Specialists, when needed, would provide supplementary care or care in partnership with the primary care physician. Adequate primary care for women included the provision of routine gynecological examinations and pap smears on a regular basis. To quantify the need for specialty physician services, classifications were developed which categorized the clients' chronic medical conditions by level. Each level corresponded to the type of medical provider most appropriate for managing the condition in the community.

- *Level 1 conditions* are managed solely by the client's primary care physician, or by the primary care physician with specialty back-up on an infrequent basis; i.e. less than once a year. For some Level 1 conditions, the extent of the specialist's role might be a one visit consultation for diagnostic purposes with subsequent management provided by the primary care physician. Level 1 care also includes preventive health care, and care for acute episodes of illness. Examples of Level 1 conditions include: occasional or borderline hypertension, and adult onset diabetes with no medication required.
- *Level 2 conditions* are characterized by increased specialty involvement. They are managed by the primary care physician with specialty back-up at least once a year or by a specialist solely at least once a year. Examples of Level 2 conditions include: recurrent otitis media, and peptic ulcer.
- *Level 3 conditions* are managed by a specialist solely whose involvement is ongoing (i.e. several visits a year). Examples of Level 3 conditions include: brittle diabetes in poor control, and uncontrolled grand mal seizures.

The physician review panel reviewed the data provided concerning chronic conditions and determined the following for each condition: 1) the system (e.g. cardiovascular, neurologic) which was involved; 2) whether the condition described was Level 1, 2, or 3; and 3) if care by a specialist was indicated, whether the client was seeing an appropriate kind of specialist. If a specialist was not being seen when necessary, or if an inappropriate type of specialist was following the condition, the service pattern was judged to be inadequate. The panel also reviewed information concerning services provided by allied health professionals and determined whether the allied health professional being seen was an appropriate provider for the condition described.

Determining Need for Home Health Services—Acknowledging that some clients have medical conditions that require ongoing care and treatment at home, the survey assessed the adequacy of home health services in a similar manner. The advisory committee began with the premise that many home health treatments can be safely provided by lay persons including parents, on the condition that the provider is trained and periodically monitored by a nurse. To quantify the need for home health services, the advisory committee developed a list of 16 home health needs commonly encountered in this population and categorized each need by level; each level carried with it a requirement for a specific degree of nursing involvement.

- *Level 1 needs* are supervised by a nurse who visits the residence on an as needed but regularly scheduled basis. Examples: prescribed topical skin treatments (e.g. lotions), weight control programs, and prescribed eye drops.
- *Level 2 needs* are supervised by a nurse who visits the residence at least once a day. Examples include: medications which require monitoring because of concerns about large dosages or potential side effects; and brittle diabetes, requiring daily insulin injections, urine tests, and diet precautions.
- *Level 3 needs* are attended to solely by a nurse. Examples include: specific nursing treatments (e.g. shunt care), catheter care, and suctioning.

The home health services section of the questionnaire included the list of home health needs developed by the advisory committee. After designating which of these needs applied to their client, service coordinators were asked to describe the client's current care pattern by indicating who attended to these needs.

Direct care by a nurse was considered an adequate care pattern for needs at all three levels. No care or care by the client alone or by an untrained, unsupervised lay person were considered inadequate patterns of care at all three levels.

Results

Sample Characteristics

As shown in Table 1, the sample closely resembled the study population in terms of sex, age, and prior institution-

TABLE 1—Distribution of Population and Sample by Age, Sex and Prior Institutionalization

Characteristics	Population (N = 1333)	Sample (n = 333)
Sex	%	%
Male	54.0	51.7
Female	45.8	48.4
Unknown	0.2	0
Age (years)		
0–17	5.2	5.4
18–21	11.0	10.8
22–44	61.3	61.6
45–64	19.6	20.4
65–98	2.0	1.8
Unknown	0.9	0
Prior Institutionalization		
Yes	33.8	33.6
No	65.6	66.1
Unknown	0.5	0.3

alization. The largest proportion of the study sample (39.3 percent) lived with their families; 36 percent lived in residential programs supervised by the state Department of Mental Health; 5.7 percent in nursing homes, and 3.6 percent in rest homes. Almost 9 percent lived independently with minimal or no supervision. The remaining clients (6.6 percent) lived in various settings including supervised residences for individuals with psychiatric conditions, and family-arranged foster homes. Sixty-six percent had never been institutionalized in a public facility for the mentally retarded. Sixteen percent lived in residential settings with nurses on site and received all or most of their health services, including physician services, within their facility. The remainder, who lived either in family situations, in residences with non-medical staff, or independently, were expected to obtain their health services from providers serving the general population.

Medicaid was the sole source of payment for health services for 65 percent; an additional 14 percent received both Medicaid and Medicare, and 5 percent were Medicare beneficiaries solely. Almost 11 percent were insured by commercial or private insurers; one percent reported "other" payment sources, and for 3 percent the payment source was unknown. Less than 3 percent reported no health insurance coverage.

Care by Primary Care Physicians—Eighty-seven percent of the sample were reported to have a regular physician (who knows the client, manages overall medical care and refers to specialists as needed). For clients younger than age 22, 49 percent were being seen by a pediatrician and another 30 percent by an internist. For older clients, 47 percent were being seen by an internist and 36 percent by a family or general practitioner. The clients who did not have regular physicians tended to be living with their families (50 percent) or living independently (27 percent).

Only 40 percent of the women ages 18 and older were known to have had a gynecological examination provided by either her primary care physician or by a gynecologist within the three-year period preceding the survey. In written comments, 7 percent of women ages 18 and older were noted to have refused gynecological examinations or to exhibit behaviors that made gynecological examinations impossible.

Care by Specialty Physicians—Sixty-two percent of the clients were judged to have one or more chronic medical conditions serious enough to warrant ongoing medical intervention: 30 percent with one condition, 14 percent with two conditions, 12 percent with three conditions, and 5 percent with four or more conditions. Eight-four percent of the chronic conditions reported were being managed by physicians, and 16 percent were managed by allied health professionals (e.g. podiatrists).

The reported prevalence of chronic conditions by systems for all clients is shown in Table 2. In terms of prevalence, the top five types of conditions were neurologic, ophthalmologic, dermatologic, psychiatric-emotional, and musculoskeletal or orthopedic. The high prevalence of neurologic conditions reflects primarily seizure disorders (16 percent). As shown in Table 3, the distribution of conditions by system and level indicates that while many of the conditions were judged manageable by a primary care physician, a substantial amount of specialty involvement is called for. Among the five most prevalent conditions, dermatologic conditions were primarily Level I conditions, while the majority of the neurologic, ophthalmologic, psychiatric-emotional and orthopedic conditions were Level 2, requiring a partnership between the primary care physician and a specialist, or Level 3, needing the ongoing involvement of a specialist. Looking at all conditions together, nearly half were judged to be Level 1, 14 percent were Level 2 and almost 40 percent were Level 3.

The allied health professionals named most frequently as managing chronic conditions were podiatrists who managed 9 percent of the conditions, and optometrists who managed almost 5 percent.

Among the previously institutionalized clients, who had been living in the community an average of 4.6 years, 20 conditions were reported in their institutional records; 13 of these conditions were reported in this survey. Of the seven conditions not reported, two involved hearing loss, one was a refractive error (good vision with glasses), two were cardiac murmurs, one was mild spastic cerebral palsy and one was hypothyroidism. Six new conditions were reported; of these, two were skin irritations requiring topical treatments; the others were a fungal infection of the nailbed, anxiety treated with medication, high blood pressure, and a heart murmur.

Among seven clients about whom physicians had provided information 18 months earlier,[7] 18 conditions were

TABLE 2—Prevalence of Chronic Medical Conditions by System for All Clients in Rank Order* (n = 333)

Condition Types by System	Percent (SE) of Clients	(n)
Neurologic	20.1 (± 2.2)	(67)
Ophthalmologic	18.6 (± 2.1)	(62)
Dermatologic	15.6 (± 2.0)	(52)
Psychiatric/emotional	10.8 (± 1.7)	(36)
Musculoskeletal (orthopedic)	9.3 (± 1.6)	(31)
Cardiovascular	8.4 (± 1.5)	(28)
Ear/nose/throat	7.5 (± 1.4)	(25)
Endocrine	5.1 (± 1.2)	(17)
Gastrointestinal	4.2 (± 1.1)	(14)
Neuropsychiatric**	3.0 (± 0.9)	(10)
Respiratory/pulmonary	2.4 (± 0.8)	(8)
Genitourinary	2.1 (± 0.8)	(7)
Nutritional	1.2 (± 0.6)	(4)
Hematologic	0.6 (± 0.4)	(2)
Gynecologic***	1.9 (± 0.7)	(3)

*31.2% of clients reported more than one chronic condition.

**Those conditions judged by the physician review panel to require *both* psychiatry and neurology services for appropriate diagnosis and treatment.

***Female clients only (161).

TABLE 3—Distribution of Chronic Medical Conditions Managed by Physicians by System and Level

Type of Condition (n)	Level 1 %	Level 2 %	Level 3 %
Neurologic (70)	40	33	27
Ophthalmologic (43)	9	0	91
Dermatologic (26)	73	0	27
Psychiatric/emotional (32)	41	19	41
Musculoskeletal (32)	34	16	50
Cardiovascular (30)	73	17	10
Ear/nose/throat (26)	46	0	54
Endocrine (17)	88	0	12
Gastrointestinal (14)	93	7	0
Neuropsychiatric (10)	10	20	70
Respiratory/pulmonary (8)	75	13	13
Genitourinary (7)	43	14	43
Nutritional (3)	33	67	0
Hematologic (2)	100	0	0
Gynecologic (3)	67	0	33
Multi-system (2)	0	0	100
100% (325)	47 (152)	14 (46)	39 (127)

reported by their physicians, 14 of which were reported in this survey. Of the unreported conditions, three were ophthalmologic (hyperopia/esotropia, light esotropia, and immature cataracts) and one was dermatologic (acne). Two new conditions were reported: chronic constipation and osteoporosis.

Adequacy of Service—As Table 4 indicates, 92 percent of conditions managed by physicians and 89 percent of conditions managed by allied health professionals were judged to be adequately managed. Information concerning conditions for which service utilization was judged to be inadequate is shown in the Appendix.

Need for Home Health Services—Fifty-seven percent of clients were reported to have a chronic condition which carried with it a need for ongoing care and treatment at home. For all clients, level of care was judged to be Level 1 in 28 percent, Level 2 in 27 percent, and Level 3 in 2 percent. The reported prevalence of home health needs is shown in Table 5. Clients who had been cared for by a nurse were found to be receiving services from a variety of agencies, with the highest proportion (15 percent) receiving services from nurses employed by their departmentally contracted residential or day program vendor. Only 3 percent were receiving services from generic home health agencies such as the Visiting Nurses Association.

Of all clients reported to have home health needs, 30 percent were judged to be receiving adequate care while 61 percent were receiving inadequate care. Another 9 percent were receiving "mixed" nursing services; some of their needs were met via an adequate service pattern while other needs received an inadequate pattern of care. For 59 percent of clients with home health needs, licensed nurses were not involved at all, either as direct care providers or as trainers and supervisors of direct care providers.

TABLE 4—Distribution of Adequacy of Service Utilization for Chronic Medical Conditions by Level

Level	Adequate	Inadequate	Unable to Judge	Total
Physician Services				
% Level I	93.4	0.7	5.9	100.0
(n)	(142)	(1)	(9)	(152)
% Level 2	87.0	4.4	8.7	100.0
(n)	(40)	(2)	(4)	(46)
% Level 3	91.3	3.2	5.5	100.0
(n)	(116)	(4)	(7)	(127)
Allied Health Services				
(%)	88.5	9.8	1.6	100.0
(n)	(54)	(6)	(1)	(61)

TABLE 5—Prevalence of Conditions Requiring Care and Treatment at Home for All Clients in Rank Order*

Conditions	Percent of Clients (SE)	(n)
Medications requiring monitoring	26.7 (± 2.4)	(89)
Diet education and weight control	21.6 (± 2.3)	(72)
Prescribed topical skin treatments	18.0 (± 2.1)	(60)
Gum care/periodontal disease	7.5 (± 1.4)	(25)
Prescribed eye or ear treatments	6.9 (± 1.4)	(23)
Chronic constipation requiring "bowel regimen"	6.0 (± 1.3)	(20)
"Other" situations requiring care and treatment	3.0 (± 0.9)	(10)
Medication IM	2.1 (± 0.8)	(7)
Brittle diabetes requiring medication and diet precautions	1.8 (± 0.7)	(6)
Total care and repositioning for skin and pulmonary reasons	1.8 (± 0.7)	(6)
Recurrent urinary tract infections requiring monitoring	1.5 (± 0.7)	(5)
Specific nursing treatments (e.g. shunt care)	1.2 (± 0.6)	(4)
Gastrostomy or colostomy care	0.9 (± 0.6)	(3)
Catheter care	0.6 (± 0.4)	(2)
Suctioning	0.3 (± 0.3)	(1)

*Some clients reported more than one condition requiring home treatment.

Other Problems Obtaining Health Services—The data suggested that some clients faced additional problems in obtaining health services. The most frequently cited barrier was a financial one. Of the 267 clients who were Medicaid recipients, almost one-fourth reported one or more instances during the survey period when a health provider refused or was reluctant to serve them because the source of payment was Medicaid.

Characteristics of the clients themselves on occasion created barriers to care. One such characteristic is the ability to cooperate with medical examinations and treatments. For 20 percent of clients, examinations and treatments were able to be completed only when supportive measures were taken to prepare the client, e.g., pre-medication or pre-visits for desensitization purposes. For eight clients, examinations and treatments were able to be completed only when extraordinary measures, such as physical restraints or general anesthesia, were taken. Some clients, while generally cooperative with medical treatment, were said to require supportive measures for specific examinations, e.g. gynecological.

Discussion

It is widely assumed that individuals with mental retardation carry a heavy burden of chronic disease requiring an extensive and highly specialized array of medical services that may be difficult to obtain in the "generic" community health care system. Several studies support this assumption.[3-8] This study, while confirming the relatively high prevalence of chronic illnesses requiring medical intervention, indicates that the vast majority of these conditions for the group studied can appropriately be managed and are being managed within the community health care system. Further, the study shows that about half of these conditions do not require the services of specialty physicians but can be managed by primary care physicians. Almost 90 percent of clients were connected with a primary care physician who served as their "regular doctor," indicating that they have obtained a portal of entry to the health care system that eludes many individuals in the general population. The findings concerning primary care for women were not as sanguine. Less than 40 percent of the women were known to have had a routine gynecological examination within the three years prior to the survey, thereby missing an important opportunity for prevention and early detection of disease. Given the lack of agreement within the medical community as to the recommended frequency of preventive gynecological examinations for the general population, Massachusetts regulations calling for yearly gynecological examinations for women appear overly rigid. Nonetheless, the provision of gynecological services for women with mental retardation appears to be poorly implemented.

The major service gap identified by this survey concerned the provision of home health care, a subject that has received little attention relative to the mentally retarded. In the judgment of the advisory committee, the optimum management of home health needs in the community service system calls for the involvement of a nurse, who would function most often as a trainer, supervisor, and monitor of lay care givers, and not as a direct care provider. This approach arose from the belief that any home health system established for this population must address the fact that most of these individuals cannot attend to their own health needs. The system must also be designed to accommodate the range of care givers in the community system who have taken on this responsibility. In particular, it must address the fact that staff in many community residential programs are young, inexperienced, and have a high turnover rate. Almost 60 percent of clients with home health needs in the sample studied had not had a nurse involved in their care at all. The remainder of clients had been seen by a nurse but in many instances the nurse acted as a short-term direct care provider and did not function in the expanded role specified by the advisory committee. Generic home health agencies are a potential source of nursing support. Less than 3 percent of the sample receiving nursing services, however, received their care from such agencies. Current regulations governing the financing of home health care by third parties may restrict the availability of services to the resolution of acute conditions and exclude management of the long-term chronic conditions seen among this population. If generic home health agencies are not a realistic source of services for mentally retarded persons in the community system, serious thought must be given to developing alternative ways to provide this essential health supervision.

The other major area of concern involved financing. At the time of the survey, the Commonwealth of Massachusetts offered generous Medicaid benefits, as compared with other states. Yet almost a fourth of the clients reported instances during the survey period when a provider refused or was reluctant to serve them because the payment source was Medicaid. Currently anticipated deep reductions in publicly financed health benefits in Massachusetts and elsewhere will undoubtedly exacerbate these problems. Such changes could place the health of retarded persons at risk. The heavy dependence of this population on publicly financed health programs in part results from the fact that mentally retarded persons as a group are generally denied access to generic health insurance programs because they are assumed to be in need of expensive and complex health services.

Sterling Garrard suggested in 1983 that the level of consumption of health services by persons with mental retardation living in the community is determined by the proportionate mix of three sub-groups.[9] The first is a low consuming group, probably comprising a sizable minority of the population, whose major service requirements are for primary care with an emphasis on health maintenance. The second is an intermediate consuming group, also estimated as a sizable minority, where increased morbidity necessitates more frequent medical encounters. The third group is a high consuming group estimated to be a small minority of the population. Their increased utilization of health services is attributable to severe chronic medical conditions. Their major service requirements are for primary care frequently supplemented by specialty consultations.

The findings of this study support Garrard's suggestion. A recent study of state Medicaid expenditures, which found that the disabled with mental retardation as their primary disability did not have higher than average expenses in most states, also supports Garrard's contention.[10] It is possible that previous studies reporting significant health problems among persons with mental retardation may have been weighted toward Garrard's high consuming group while the two latter studies included individuals from all three groups. Further research is imperative to confirm or challenge these findings; such data are critical to efforts to advocate that persons with mental retardation have access to the health care organizations and insurance programs available to the general population.

Some underreporting of chronic medical conditions undoubtedly occurred in this study. The need to employ respondents who were comparable for all subjects despite their different living arrangements led to the decision to select the service coordinators as respondents despite the fact that they might not have the same first-hand knowledge of the client's health status as the client's physicians, parents, or residential program staff. To minimize underreporting, service coordinators were instructed to report all medical conditions noted in the client's record which contains the report of the client's most recent physical examination (in all cases completed by a physician within the past year) as well as treatment plans to address the client's major needs. If the record information was incomplete, the client's family or residential program staff were contacted. In addition, all prescribed medications used by the client within the past 12 months were noted and checked to ensure that each was linked to a medical condition reported in the questionnaire. These two checks showed that from 65 to 78 percent of all chronic conditions were reported in the record, and that unreported conditions were predominantly Level 1, the least serious conditions.

A second potential source of underreporting was the study's focus on individuals in the community who were receiving services from the state mental retardation agency. There are mentally retarded individuals in every community who are not known to public agencies, although their numbers are difficult to estimate. It is generally understood, however, that those individuals in the greatest need of services are the most likely to turn to the state agency for assistance. For adults, it is unlikely that individuals who were not being served by the state agency would have a higher prevalence of conditions than clients in this study. The needs of individuals under age 22, however, may be underrepresented, since in Massachusetts, the Department of Education and not the Department of Mental Health, is the primary provider of services for persons with mental retardation under age 22. The small proportion of children under 18 years of age in our survey reflects this fact.

Finally, it is important to note that good health care comprises more than simply obtaining the services of appropriate physicians, allied health professionals, and home health providers. Quality of care considerations, while very important, were beyond the scope of this survey. Some responses also indicated that many clients had encountered particular types of problems when seeking health care, including, at times, negative attitudes toward or poor interpersonal skills with mentally retarded patients. Future research efforts should attempt to describe more completely these and other barriers to obtaining health services in the community. Preventive health services and the availability of ancillary and rehabilitative services such as physical therapy and adaptive equipment services deserve particular attention.

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APPENDIX

Medical Conditions with Inadequate Service Utilization among Mentally Retarded Clients

Physician Services

- One Level 1 skin condition was managed by a psychiatrist; dermatologist recommended.
- One Level 2 cardiovascular condition was managed by a general practitioner; cardiologist recommended.
- One Level 2 psychiatric/emotional condition was managed by a general practitioner; psychiatrist recommended.
- One Level 3 eye condition was managed by an optometrist; ophthalmologist recommended.
- One Level 3 eye condition was managed by an ENT; ophthalmologist recommended.
- One Level 3 neurological condition was managed by a neurologist; neuropsychiatrist (behavioral neurology) recommended.
- One Level 3 neurological condition was managed by a psychiatrist; neurologist recommended.

Allied Health Services

- Two eye conditions were managed by optometrists; recommended provider types were ophthalmologists.
- Three skin conditions were managed by podiatrists; recommended provider types were dermatologists.
- One gastrointestinal condition was managed by a homeopath; recommended provider type was a gastroenterologist, possibly with consultation from a psychiatrist.

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Some of these data were presented at the 113th annual meeting of the American Public Health Association in Washington, DC 1985.

NIH Consensus Statement on Surgery for Epilepsy now Available

A National Institutes of Health (NIH) consensus development statement on Surgery for Epilepsy has been developed by a panel of experts who considered scientific evidence at a Consensus Development Conference held March 19–21, 1990 at NIH.

Single copies of the report, or the two-page summary, may be obtained from: William H. Hall, Director of Communications, Office of Medical Applications of Research, NIH, Building I, Room 259, Bethesda, MD 20892. Tel: (301) 496-1143.

Homeless and Housed Families in Los Angeles: A Study Comparing Demographic, Economic, and Family Function Characteristics

David Wood, MD, MPH, R. Burciaga Valdez, PhD, MHSA, Toshi Hayashi, PhD, and Albert Shen, MPH

Abstract: We studied 196 homeless and 194 housed poor families in Los Angeles, California to gain an understanding of events that precipitate family homelessness. Both homeless and housed poor mothers averaged 29 years old and were accompanied by two or three children. Three-fourths of both the homeless and housed families had income below the poverty level, and both groups expended almost two-thirds of their income on housing. Mothers in homeless families more commonly reported spousal abuse (35 vs 16 percent), child abuse (28 vs 10 percent), drug use (43 vs 30 percent), or mental health problems (14 vs 6 percent) and weaker support networks. Homeless mothers more commonly came from homes where their parents abused drugs or alcohol (49 vs 34 percent) or more commonly lived outside the home or in foster care (35 vs 25 percent). Homelessness was reported as due primarily to economic pressures of housing costs, but personal and family problems frequently played a contributing role, especially for single parent families. Burdens of increasing housing costs and family dysfunction among housed poor families place many at risk for homelessness. (*Am J Public Health* 1990; 80:1049–1052.)

Introduction

Families make up over one-third of the homeless nationwide, and in many large cities (e.g., New York, Philadelphia, Portland) families represent the majority of the homeless population.[1] Los Angeles has approximately 35,000 to 50,000 homeless persons, about one-third of whom are members of homeless families.[2] The growth of the homeless family population has been attributed to increasing poverty among families combined with rising housing costs[3] and family dysfunction.[4-6]

A number of studies indicate that changes have occurred in the composition of the homeless family population over time and that important geographic variations exist.[1,7-10] Yet, with the exception of one study in Boston,[4] only descriptive studies of the homeless family population are available. To shed more light on the composition of homeless families and gain a better understanding of the precipitating events of homelessness among families, we surveyed 196 homeless families in shelters and compared them to 194 housed, poor families in Los Angeles, California. The health status of homeless and housed children was also assessed and those comparisons are presented elsewhere.[11]

Methods

Homeless families (n = 196) and a comparison group of stably housed, poor families (n = 194) were interviewed during March 1987 through early 1988 in Los Angeles, California. From a universe of 23 shelters serving families in Los Angeles, homeless families were sampled from the 10 largest and busiest shelters. These 10 shelters received 80 percent of all family shelter referrals in Los Angeles during the three months preceding the study. Interviewers visited each shelter at least weekly during the interview period and sampled families from among those who had come to the shelter within the past week. In the five smaller shelters (less than 10 families) a complete sampling of the new families was attempted. In the five larger shelters every other new family was selected for an interview. If after two attempts we failed to locate a family, we approached the next family on the roster.

The housed, poor families were systematically sampled from families presenting to four welfare offices, selected on the basis of the geographic distribution of the "last stable address" of the homeless families. In the welfare offices we screened all presenting families and requested an interview from those who had lived in their current residence at least six months and had received welfare benefits continuously for at least one year. Of the 240 families we sought to interview, 46 refused to participate. There were no differences in age or ethnicity of the mothers who refused compared to the respondents.

Interview and Questionnaire

Structured interviews were conducted with the mothers by trained interviewers and lasted approximately 45 minutes.

Families were categorized as female, single-parent or two-parent families based on whether the mother reported that she was currently with an adult male partner. The mothers were asked if they had been abused in their current or most recent significant relationship, if they or their partner abused drugs or alcohol, and if they or their partner had a history of hospitalization for mental illness. Mothers also were asked if, in her family of origin, there was a history of family violence, drug or alcohol abuse, or mental illness. The quantity and quality of maternal social supports were assessed by documenting the total number of persons the mother could rely on for support, the ages of the supports, and the mother's relationship to the supports.

Family income was a summation of the total income contributed from all family members over the past year and was further assessed by source. The percent of income expended on housing was derived by dividing reported rent and utility expenditures by the average monthly income. For homeless families, we asked them to report the rent and utility costs at their last stable residence (defined as the family having their own place for at least two months' duration).

Housing histories included the number of moves over the past five years and the types of living situations experienced (doubled up with strangers, living in a hotel or motel, living in a car or on the street). Homeless families were asked to describe the events leading to their loss of housing. For each

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narrative, two raters independently identified a primary precipitating event which were then grouped into five categories: 1) *Economic*—such as job loss or loss of AFDC (aid to families with dependent children) grant income; 2) *Housing-related*—such as eviction, failure to pay rent, conversion, or demolition; 3) *Marriage or family relationship* problems; 4) *Violence* and/or drug related; 5) *Natural disaster*. When multiple events were described, the rater sought to identify the initiating or underlying event. For example, where income loss lead to eviction the primary event was classified as "income loss."

Analysis

The homeless and housed samples were compared using simple comparison of means and proportions and two-tailed t-test and Chi-square analysis. We report 95 percent confidence intervals for the differences in means and proportions. Multiple regression as used to test each comparison while controlling for potentially confounding factors of race, maternal education, child sex, child age, and family structure. The qualitative results remained unchanged, so we report the unadjusted comparisons for simplicity.

Results

Demographics and Family Structure

The majority of homeless and housed mothers in our sample were Black, and averaged 29 years of age (Table 1). A larger proportion of the homeless mothers were White. Homeless mothers reported larger families and were less likely to have graduated from high school. More of the homeless families were headed by two parents and and more of the homeless couples than housed couples had been together for over one year (Table 1).

Family Problems and Maternal Social Supports

Homeless mothers reported more spousal abuse and drug abuse by their mates and were more likely to have had a child abuse report opened on the family and more likely to have personally required hospitalization for mental illness (Table 2). Both the homeless mothers and housed mothers frequently reported using drugs such as crack and heroin (32 percent and 26 percent, respectively).

TABLE 1—Demographic Characteristics of Homeless and Housed Women and Families

Characteristic	Homeless Families (n = 196)	Housed Families (n = 193)	Difference of Homeless-Housed (95% confidence interval)
Maternal ethnicity (%)			
Black	57	70	−13 (−22, −4)
Non-Latino White	30	15	15 (7, 23)
Latino	8	11	−3 (−9, 3)
Other	6	4	2 (0, 4)
Percentage of mothers with high school diploma or some college	57	72	−15 (−24, −6)
Percentage of families with two parents (versus single-parent, female-headed)	47	38	9 (1, 19)
Percentage of two-parent families together more than one year	83	62	21 (12, 30)
Mean number of children per family	2.7	2.3	0.4 (0.1, 0.7)
Mean Maternal age	29.5	29.0	0.5 (−1, 2)

TABLE 2—Percentage of Mothers Reporting Violence, Drug or Alcohol Abuse, Criminal Involvement, and Mental Health Problems

Family or Personal Problem Reported	Homeless Families (n = 192)	Housed Families (n = 190)	Difference of Homeless-Housed (95% confidence interval)
Violence			
Mate abuses mother	34	16	16 (9, 25)
Mate involved in criminal activity	29	20	9 (0.4, 18)
Social service file opened for child abuse or neglect	28	10	18 (14, 22)
Drug Alcohol Abuse			
Mate abuses alcohol or drugs	43	30	13 (3, 23)
Mother abuses drugs	32	26	6 (−3, 15)
Mental Ilness			
Mate has history of mental illness	15	11	4 (−3, 11)
Mother has history of hospitalization for mental health problem	14	6	8 (2, 14)

A history of substance abuse and family violence were more often reported for the homeless mothers' own family of origin (Table 3). Over one-third of the homeless mothers reported being placed with relatives or in foster care as children compared to one-fourth of the housed mothers.

Two-thirds of homeless mothers named only one or no adult supports compared to one-half of housed mothers (Table 4). Fewer homeless mothers could rely on their parents for support, and they were more likely to rely on their own minor children for support than were housed mothers.

The single-parent homeless families reported many more relationship problems, such as drug abuse or violence than did the two-parent homeless families (means: 1.9 vs 1.2; Diff = 0.7, 95% CI = .39, .99). Single-parent homeless mothers also reported a mean of fewer adults in their network of social supports than the two-parent homeless families (1.3 vs 2.2, Diff = −.9, 95% CI = −1.34, −.37); and single-parent homeless mothers more often named their minor children as their primary supports than the two-parent homeless families. In contrast, the two-parent homeless families were very

TABLE 3—Percentage of Homeless and Housed Mothers Reporting Problems in Their Own Families of Origin

Problem Reported by Mother	Homeless Families (n = 195)	Housed Families (n = 189)	Difference of Homeless-Housed (95% confidence interval)
Mother's family of origin headed by single, female	40	47	−7 (−17, 3)
Mother's parents divorced or death of parent(s)	43	36	7 (−3, 17)
Mothers parent(s) abused drugs or alcohol	49	34	15 (5, 25)
As a child, mother lived with a relative or in foster care	35	25	10 (1, 19)
Mother was physically or sexually abused by parent(s)	31	21	10 (1, 19)

TABLE 4—Number and Type of Social Supports Reported by Homeless and Housed Mothers

	Homeless Mothers	Housed Mothers	Difference of Homeless-Housed (95% confidence interval)
Mean number of adult supports named by mother (n = 189, 184)	1.75	2.22	.48 (0.11, 0.85)
Percentage of mothers reporting:			
1 or no adult support	66	48	18 (8, 28)
2 or 3 adult supports	26	36	−10 (−19, −1)
4 or more adult supports (n = 196, 194)	8	16	−8 (−14, −2)
Percentage of mothers naming own mother or father as a support (n = 196, 194)	31	65	−34 (−43, −25)
Percentage of mothers naming own child less than 18 years old as a support (n = 165, 167)	37	13	24 (15, 33)

similar to the two-parent housed families on measures of social support and family relationship problems.

Family Income, Housing Costs and Housing Histories

After adjusting family income for family size, over three-fourths of the families in both groups had incomes below the poverty level (in 1987 the poverty level for a family of three was $8940,[12] (Table 5). The income of the housed families came almost exclusively from welfare, whereas only 61 percent of homeless families were dependent exclusively on welfare (27 percent depended on the mother's or father's income exclusively or as a supplement to welfare, and 12 percent reported no income at all). Although AFDC was a primary source of income for homeless families, 43 percent reported losing or being removed from the welfare rolls during the past year.

Families in both the homeless and housed groups reportedly spent or had spent about two-thirds of their monthly income on rent and utilities (means: 67 percent vs 64 percent), and about one-fourth of each group had rent-to-income ratios above 80 percent (Table 5). Only about 15 percent of families in each group had rent-to-income ratios below 30 percent, the upper limit recommended by the federal housing guidelines.[13]

Homeless families reported long histories of housing instability, averaging 3.7 moves in the past year. Over 40 percent of the homeless families reported more than five moves in the past five years. During the past five years over half of the families had doubled-up with others (56 percent), three-fourths had lived in a hotel or motel (76 percent), and one-third had lived on the street or in a car (32 percent).

TABLE 5—Reported Family Income, Rent Burden for Homeless and Housed Families

	Homeless (n = 196)	Housed (n = 194)	Difference of Homeless-Housed (95% confidence interval)
Mean family income	9,739	8,150	1589 (677, 2500)
Percentage of Families with income below poverty line	82	88	−6 (−13, 1)
Mean rent to income ratio	0.67	0.64	0.03 (−0.7, 0.13)
Mean number of moves over the past five years	5.9	2.3	3.6 (2.8, 4.4)

Although the housed families were chosen on the basis of their recent housing stability, many had experienced housing instability over the past five years. Almost two-fifths (39 percent) of the housed families reported that, sometime during the past five years, they had doubled up with strangers for housing, and almost one-fifth (19 percent) reported that they had lived in a hotel, motel, a car or a shelter. Thus, during the past five years, two out of five housed, poor families had experienced unstable living situations and one in five had been homeless.

Precipitating Causes of Homelessness

The majority of homeless families (57 percent) described economic problems (i.e., job loss, loss of AFDC) or housing problems (i.e., eviction) as the primary precipitating cause of their homelessness; one-fourth described personal or family problems, such as a relationship breakup or estrangement from the extended family. Violence or drug problems were described as the primary causes of homelessness by 11 percent of the families. The distribution of precipitating events, however, was quite different for two-parent compared to single-parent homeless families. Two-parent families were more likely to cite economic or housing problems as precipitating events for homelessness than single-parent families (72 percent vs 48 percent; Table 6). Single-parent families were more apt to cite family problems as primary precipitant of homelessness than two-parent families (31 percent versus 16 percent).

Discussion

Previous surveys and earlier studies in various locales describe the homeless family population as predominantly composed of single-parent, female-headed families.[4,5,8,14] Yet almost half of our sample of homeless families was composed of two-parent families, most of whom had been together for over one year. Recent studies in Seattle, Portland, and other cities have similarly found approximately half of homeless families to be two-parent families.[1,7]

Previous homeless studies may have underestimated the proportion of two-parent families because they questioned only shelter directors or other "key" informants, or because two-parent families tend to falsely report themselves as single-parent families in order to qualify for services, including emergency shelter itself.[15] The high prevalence of two-parent families among homeless families has important implications for our public policy of family assistance. Due to categorical qualification criteria, two-parent families are less frequently eligible for family assistance programs such as

TABLE 6—Distribution of Reported Causes of Homelessness in Single-Parent versus Two-Parent Homeless Families

Percentage of Families Reporting Cause of Homelessness	Two-Parent-Families (n = 90)	Single-Parent Families (n = 97)	Difference of Two Parent-Single Parent (95% confidence interval)
Housing problems	34	28	6 (−7, 19)
Economic problems	38	20	18 (5, 31)
Family/relationship problems	16	31	−15 (−27, −3)
Related to drug use or violence	8	14	−6 (−15, 3)

Medicaid, the Homeless Family Assistance Program in California, and AFDC. These policies promote family separation and actually may precipitate homelessness.

Prior to becoming homeless, families were expending such high proportions of their income on housing that they had few resources remaining to meet other basic necessities such as food and clothing.[11] Our sample of stably housed families also reported equally high rent-to-income ratios of 60 to 80 percent, which puts them at great risk for housing loss; many reported doubling up or even experiencing short periods of homelessness over the past five years.

Millions of families nationally, including over two-thirds of all families on AFDC, expend over 50 percent of their family income on housing, and are severely rent burdened.[13,16–18] In almost all states, AFDC grants are well below the poverty level and in many states the entire AFDC grant does not reach the level of the lowest local Fair Market Rent.[19] AFDC grant levels must at least be raised to the federal poverty level, and should ideally be indexed to local fair market rents in order that families not expend more than 30 percent of their grant on housing.

Homeless families frequently experienced discontinuations of welfare assistance for administrative reasons rather than due to increased family income. This caused the family financial hardship and usually played an important role in their loss of housing. Nationwide, as many as 25 percent of welfare families annually experience administrative discontinuations without necessarily any change in their family income.[20,21] Welfare administrative procedures should be modified to promote rather than undermine the economic stability of fragile families and thereby prevent rather than precipitate their loss of permanent housing.

The stress of homelessness, pre-existing family problems, and weak support networks increase the likelihood that homeless families will not obtain access to our fragmented social service system. Family outreach services and comprehensive case management should be offered to assist homeless families to resolve family problems, secure permanent housing, and prevent future homeless episodes.[20,22] The outreach and case management services should include crisis intervention, assistance with program enrollment and benefit maintenance, family counseling, job training, and rehabilitation for drug dependence.

Several issues regarding our sampling strategy should be noted. We may have overrepresented newly homeless families and underrepresented families who have been homeless in the same shelters for longer periods. Further, due to logistical problems in the field and the limited resources of the study, the sampling in some shelters occasionally was reduced to a convenience sample of families. This limitation represents a common problem among published studies in this field.[23] Lastly, the housed, poor family sample may overrepresent Blacks and underrepresent Latinos compared to the overall AFDC population in Los Angeles; the difference resulted largely from our geographic selection of welfare offices to represent the homeless families' neighborhoods of origin.

In summary, the most common contributing factors to the loss of permanent housing among our sample of homeless families were high housing costs and family poverty. Interpersonal problems and social isolation also played a role in the loss of permanent housing, especially among the single-parent families. Housing costs continue to rise and family poverty is worsening, putting millions of American families at risk for losing permanent housing independent of the presence of interpersonal problems.

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Racial Differences in Serum Cotinine Levels among Smokers in the Coronary Artery Risk Development in (Young) Adults Study

LYNNE E. WAGENKNECHT, DRPH, GARY R. CUTTER, PHD, NANCY J. HALEY, PHD, STEVE SIDNEY, MD,
TERI A. MANOLIO, MD, MHS, GLENN H. HUGHES, PHD, AND DAVID R. JACOBS, PHD

Abstract: Cotinine was measured in the serum of nearly all 5,115 18–30 year old, Black and White, men and women participating in the Coronary Artery Risk Development in (Young) Adults Study, 30 percent of whom reported current cigarette smoking. Ninety-five percent of the reported smokers had serum cotinine levels indicative of smoking (>13 ng/ml). The median cotinine level was higher in Black than White smokers (221 ng/ml versus 170 ng/ml; 95 percent CI for difference: 34, 65) in spite of the fact that estimated daily nicotine exposure and serum thiocyanate were higher in Whites. The difference persisted after controlling for number of cigarettes, nicotine content, frequency of inhalation, weekly sidestream smoke exposure, age, gender, and education. A reporting bias and nicotine intake were ruled out as explanations for the racial difference suggesting that the metabolism of nicotine or the excretion of cotinine may differ by race. Racial differences in cotinine levels may provide clues to the reasons for the observed lower cessation rates and higher rates of some smoking-related cancers in Blacks. (*Am J Public Health* 1990; 80:1053–1056.)

Introduction

Cotinine, a major metabolite of nicotine, is currently considered the best indicator of tobacco smoke exposure.[1] It is specific for nicotine, has a long half-life (15–40 hours), and its level is thought to be directly proportional to the quantity of absorbed nicotine.[2] The quantity of nicotine absorbed by smokers is quite variable, being dependent upon its concentration in the smoke, the individual's smoking pattern, and the smoke pH.[3] Less is known regarding characteristics which influence the circulating levels of nicotine and cotinine or their maintenance in body fluids.[4–6] Such information may assist in the study of nicotine addiction and illnesses attributable to the toxic effects of this drug.

This paper will assess the differences in cotinine levels in a biracial group of young adults who, as determined by self-report, are cigarette smokers. Possible behavioral and metabolic differences which might account for this observation are evaluated.

Methods

The Coronary Artery Risk Development in (Young) Adults Study (CARDIA) is a longitudinal study of the antecedents and risk factors for cardiovascular disease in a cohort of 5,115 Black and White men and women ages 18–30 years at their initial examination in 1985. The sample was recruited to achieve approximately balanced subgroups of self-reported race, gender, education (high school or less and more than high school) and age (18–24 and 25–30 years) in Birmingham, AL; Chicago, IL; Minneapolis, MN; and Oakland, CA. Data were collected on a variety of risk factors as previously described.[7]

This report focuses on subjects who reported, on an interviewer-administered questionnaire, current, regular cigarette smoking of at least five cigarettes per week almost every week for at least three months. Smokers were queried regarding the frequency of inhalation, the number of cigarettes smoked daily, the total number of years of regular smoking, and current as well as past brand choices including questions about cigarette length, flavor, and filter. Information was also collected on cigar, pipe, smokeless tobacco, and nicotine gum use as well as weekly exposure to sidestream smoke.

The amount of tar, nicotine, and carbon monoxide in the cigarette brands was estimated from the Federal Trade Commission (FTC) Report on January 1985.[8] A crude measure of daily nicotine exposure was estimated as the reported number of cigarettes smoked per day × the nicotine content of the reported cigarette brand.

Blood was collected under a standardized protocol. A 1 ml aliquot of serum was frozen and shipped to the Clinical Biochemistry Laboratories at the American Health Foundation. Cotinine was determined by radioimmunoassay using the method of Haley, *et al*,[9] after a modification of the method described by Langone.[10]

A 3.4 percent sample of randomly selected blind duplicates was submitted by the field centers over the entire study period for an external assessment of quality. Cross-classification of the duplicate samples of both smokers and nonsmokers over five categories of cotinine levels (0–13 ng/ml, 14–99, 100–249, 250–499, ≥ 500) yielded a 91 percent (177/194) exact agreement rate. The agreement declined as the cotinine levels increased. Internal quality control was maintained as well; the interassay coefficient of variation was 7 percent.

Thiocyanate (SCN) was also quantitated by the laboratory according to the automated procedure described by Butts, *et al.*[11] SCN is a metabolite of hydrogen cyanide, a toxic gas present in tobacco smoke. It also occurs naturally in certain foods, making it a less specific marker of cigarette

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Address reprint requests to Lynne E. Wagenknecht, CARDIA Coordinating Center, Medical Towers Building, Room 504, 1717 11th Avenue South, Birmingham, AL 35205. Dr. Wagenknecht is also with the Department of Epidemiology, University of Alabama at Birmingham, School of Public Health. About the co-authors: Dr. Cutter is with the Biostatistics and Information Systems Division, St. Jude Children's Research Hospital, Memphis, TN; Dr. Haley is with the Division of Nutrition and Endocrinology, Naylor Dana Institute for Disease Prevention, American Health Foundation, Valhalla, NY; Dr. Sidney is with the Division of Research, Kaiser Permanente Medical Care Program (Northern California Region), Oakland, CA; Dr. Manolio is with the Division of Epidemiology and Clinical Applications, National Heart, Lung and Blood Institute, National Institutes of Health, Bethesda, MD; Dr. Hughes is with the Department of General and Preventive Medicine, Behavioral Medicine Unit, University of Alabama at Birmingham; Dr. Jacobs is with the Division of Epidemiology, School of Public Health, University of Minnesota, Minneapolis, MN. This paper, submitted to the Journal August 4, 1989, was revised and accepted for publication December 26, 1989.

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smoking.[9] The decision to analyze SCN on a subset of samples was made after the start of the examination. Thus, SCN analyses were performed on samples left from the cotinine assays. Although the laboratory selected the subset, their selection criteria were based on the sample cotinine level and not the demographic characteristics of the subjects. SCN was measured on approximately 75 percent of the smokers.

Confidence intervals and statistical tests for the cotinine values are based on the Wilcoxon rank sum procedure. Similarly, Spearman nonparametric correlations were calculated for cotinine and other variables. Correlation coefficients were compared using the Fisher's Z transformation.[12]

A number of linear models were examined to assess the contribution of each of the independent variables to the cotinine measurement. We have chosen to present the multiple linear regression model of the untransformed cotinine because of its simplicity and because the variance of cotinine was reasonably stable over all levels of nicotine exposure. Other models, including log cotinine as the dependent variable, produced similar results. Separate analyses were performed for each of the four geographic areas as a check of the consistency of the major findings. All analyses were performed using the Statistical Analysis System (SAS).[13]

Results

Current cigarette smoking was reported by 1,545 (30 percent) of the 5,115 subjects; characteristics of these smokers have been described previously.[14] One-hundred-twenty-one participants were excluded from analyses (18 were missing the serum cotinine measure, 68 had uncodable cigarette brands, and 35 were regular users of cigars, pipes, smokeless tobacco, or nicotine gum). This left 1,424 (92 percent) smokers available for analyses.

Self-report appeared to be a satisfactory indicator of cigarette smoking when compared to serum cotinine levels. Overall, 95.0 percent of subjects who reported current smoking had cotinine levels > 13 ng/ml[15] (positive predictive value, PPV) while only 5.4 percent of the reported 3,508 non-smokers had cotinine levels above this cutpoint (false negative rate). PPV and false negative rates were slightly lower in Whites than Blacks (PPV: 92.9 percent vs 96.6 percent; false negative rates: 4.5 percent vs 6.5 percent).

Cotinine levels were higher in Black smokers than in White smokers; however, the estimated daily nicotine exposure and thiocyanate levels were higher in Whites than Blacks (Table 1). Black subjects smoked cigarettes of higher nicotine content and more frequently chose mentholated brands. White subjects smoked a greater number of cigarettes per day and reported more frequent inhalation than Black smokers. Fifty-five percent of Black smokers smoked one of two specific brands of cigarettes while only 10 percent of White smokers smoked these brands.

The highest correlation between cotinine and the other exposure measures (cigarettes smoked per day, daily nicotine exposure, thiocyanate, nicotine content of the cigarette) was found with the reported number of cigarettes smoked per day; the correlation coefficient was lower in Black smokers than White smokers (0.46 versus 0.64, $p < .0001$).

Cotinine levels were higher in Blacks in each category of the number of cigarettes smoked per day (significant for all but 21–40 cigarettes category, Figure 1), yet thiocyanate levels were not different between the races except for the upper category in which White smokers had greater levels (Figure 2). A racial comparison of cotinine and thiocyanate levels by daily nicotine exposure produced similar results.

Cotinine levels were 83.3 ng/ml higher in Black smokers than White smokers after adjusting for the number of cigarettes per day, nicotine content of the cigarette, years of smoking, inhalation frequency, weekly sidestream smoke exposure, age, education, and gender (Table 2). No two-way interaction terms yielded significant regression coefficients. Marijuana use and body mass index were also examined and although both yielded significant negative coefficients, only a modest reduction in the race coefficient was observed. The results of a similar regression on thiocyanate showed no association with race.

The race differential was explored further. In each of the four separate linear regression models representing the CARDIA centers, and including all the factors listed in Table 2, the

TABLE 1—Means and Standard Deviations (or Proportions) and 95% Confidence Intervals (CI) for Racial Differences of Selected Variables Among CARDIA Smokers

	Men			Women		
	White (N = 273)	Black (N = 388)	(95% CI for Difference)	White (N = 329)	Black (N = 434)	(95% CI for Difference)
Age (years)	25.4 ± 3.4	24.6 ± 3.8	(0.3, 1.4)	25.0 ± 3.5	25.0 ± 3.7	(−0.5, 0.5)
Education (years)	13.4 ± 2.3	12.2 ± 1.6	(0.9, 1.5)	13.3 ± 2.1	12.6 ± 1.6	(0.4, 1.0)
Cotinine (ng/ml)	210.2 ± 145.1	244.8 ± 156.2	(11.4, 57.8)	176.4 ± 137.6	251.2 ± 175.6	(52.6, 97.0)
(median)	(205)	(219)	(7, 54)	(152)	(222)	(44, 85)
Thiocyanate (μmol/l)*	160.4 ± 46.5	148.0 ± 46.0	(4.2, 20.6)	162.7 ± 53.7	152.2 ± 52.8	(1.5, 19.5)
Nicotine Content of Cigarette (mg)**	0.84 ± 0.25	1.03 ± 0.21	(.15, .23)	0.80 ± 0.27	1.00 ± 0.24	(.16, .24)
Cigarettes per Day	18.1 ± 10.6	10.8 ± 7.2	(5.9, 8.8)	14.9 ± 9.8	10.6 ± 6.7	(3.1, 5.5)
Daily Nicotine Exposure (mg/day)***	14.9 ± 9.7	11.2 ± 8.0	(2.3, 5.1)	11.9 ± 8.8	10.6 ± 7.2	(0.1, 2.5)
Sidestream Smoke Exposure (hrs/wk)	21.0 ± 24.5	19.5 ± 22.4	(−2.2, 5.2)	23.0 ± 25.4	22.1 ± 25.2	(−2.7, 4.5)
Inhaling "Always" (%)	69	57	(5, 19)	76	51	(18, 32)
"Almost Always" (%)	26	24	(−5, 9)	19	27	(2, 14)
Smoking Mentholated (%)	24	87	(57, 69)	34	91	(51, 63)

*WM n = 198; BM n = 320; WW n = 223; BW n = 347.
**nicotine content of cigarette, coded from 1985 FTC report.
***calculated as nicotine (mg) × cigarettes per day.

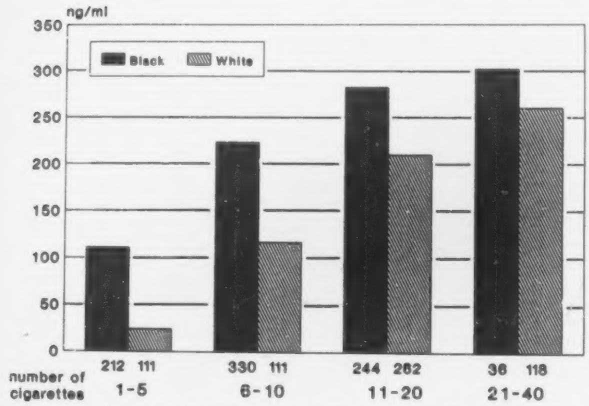

FIGURE 1—Median Cotinine (ng/ml) by Daily Number of Cigarettes Smoked
Numbers directly below bars are sample sizes. Racial comparisons within category of cigarettes smoked are significant ($p < .0001$), except for 21–40 cigarettes category ($p = .34$). Nine White subjects who reported smoking > 40 cigarettes per day were excluded.

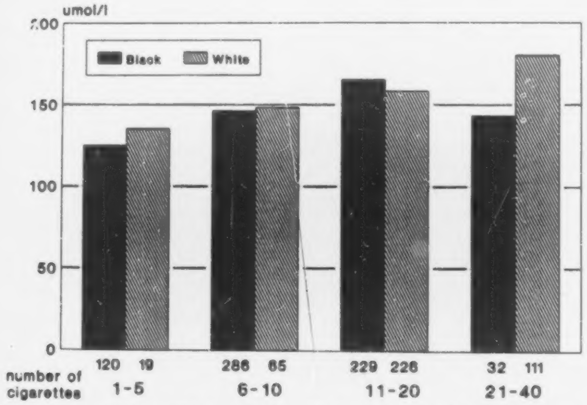

FIGURE 2—Median Thiocyanate (umol/l) by Daily Number of Cigarettes Smoked
Numbers directly below bars are sample sizes. Racial comparisons within category of cigarettes smoked are not significant except for 21–40 cigarettes category ($p < .001$). Nine White subjects who reported smoking > 40 cigarettes per day were excluded. Median thiocyanate is nearly identical to the mean; the median is presented for comparability to Figure 1.

race coefficient was found to be significant and consistent (Birmingham, 72.3; Chicago, 125.6; Minneapolis, 73.5; Oakland, 88.0; all $p < .0001$). The race coefficient was also significant in models representing smokers of mentholated (89.0, $p < .0001$) as well as non-mentholated cigarettes (51.5, $p = .0009$). Highly significant racial differences were also present in all three educational groups (< 12 years, 12 years, > 12 years) examined.

Discussion

In this cohort of smokers, race was strongly and consistently associated with serum cotinine even after adjustment for factors known to affect its concentration. To our knowledge, this finding has only been reported in one other study, as a chance finding[16]; misreport of exposure or metabolic differences were considered as an explanation of this finding in that study. As expected, we found that individual smoking patterns were also important factors in the prediction of cotinine levels in CARDIA smokers, with the quantity smoked most strongly correlated with cotinine in univariate and multivariate analyses.

There are several possible explanations for the higher cotinine levels in Black smokers. First, a reporting bias could account for the difference. A number of studies have shown that smokers tend to underreport their consumption of cigarettes.[17] However, a race differential in reporting appears unlikely (as was also shown in the National Health Interview Survey[18]). Our calculations indicate that all Black smokers would have to smoke nearly two times what they report to eliminate the race differential. Also, thiocyanate levels were equivalent between the races when the quantity smoked is taken into account (except in the 21–40 cigarettes category in which White smokers had higher thiocyanate levels). This also suggests that self-report is comparable between the races. Furthermore, underreporting might be expected to be different in various educational levels: however, we found the race differential in cotinine levels in all educational groups. The race differential in the false negative rate was also examined as a contributor to the cotinine differential. If, among Blacks, a large number of light smokers reported not smoking (false negatives), the average cotinine level reported here for Blacks may be inflated. However, upon examination of all participants considered "smokers" by their cotinine level, similar racial differences in the average cotinine level were observed. None of these findings supports a reporting bias as an explanation for the race differential in cotinine levels.

There are a number of factors in the style of smoking such as depth and frequency of inhalation, unsmoked butt length, and obstruction of filter ventilation which affect exposure.[17] Inhalation differences between the races in CARDIA favored higher nicotine exposure in the White smokers; this was not observed in the cotinine results. The amount of the cigarette which was smoked and the degree of filter obstruction were not ascertained from the CARDIA smokers. Possible differences in these factors could only partially account for higher cotinine levels in Black smokers.

We conclude that neither the number of cigarettes

TABLE 2—Multiple Linear Regression Coefficients of Serum Cotinine on Several Variables in CARDIA Smokers

Variables	β Coefficient (Std Error)
Demographic	
Race	
Black	83.3 (8.9)
White	Reference
Education (years)	−4.9 (2.2)
Age (years)	−0.1 (1.4)
Sex	
Men	−2.9 (7.6)
Women	Reference
Smoking	
Cigarettes per Day	6.9 (0.5)
Number of Years of Regular Smoking	3.8 (1.2)
Nicotine Content of Cigarette (per 0.1 mg)	5.6 (1.6)
Inhalation	
Always	11.3 (11.6)
Almost Always	35.2 (12.7)
Partially, Rarely or Never	Reference
Sidestream Smoke Exposure (hrs/wk)	0.3 (0.2)

$R^2 = 0.23$.

smoked, the nicotine content of the cigarette, nor the frequency of inhalation can account for the observed racial difference in cotinine. It is possible that our adjustment for these or other unknown variables has been inappropriate. For example, since Blacks differed from Whites in the brands they smoked, a particular brand of cigarette may be the culprit. Mentholation might also account for differences. Mentholated cigarettes, smoked by 89 percent of Black smokers but only 30 percent of White smokers, might account for underreporting of inhalation frequency because of the anesthetic effect that menthol provides. A deeper and more frequent inhalation pattern in such smokers might result in a greater nicotine exposure and thus higher cotinine levels. However, cotinine levels, adjusted for the known covariates, were significantly higher in Blacks smoking non-mentholated cigarettes as well as in those smoking mentholated cigarettes. Mentholation does not appear to explain the race differential.

Finally, differences may exist in nicotine absorption or nicotine metabolism between the races. Tolerance to nicotine has been shown to be regulated by genetic factors in mice.[19] In man, ethnic differences are known to exist in the metabolism of drugs and other xenobiotics,[20] of which nicotine is an example. The finding of racial differences in cotinine levels across geographic areas and gender groups are consistent with a genetic mechanism.

Furthermore, the induction of microsomal enzymes might be varied across the two groups or differences in urine elimination[4] of nicotine or cotinine might account for the dissimilarity. Blacks could excrete less unmetabolized nicotine than Whites due to urine pH differences or metabolic induction. Additionally, diet could influence urine output and pH in one racial group. We were unable to address these possible explanations in this study.

The possible association of racial differences in cotinine levels to two public health issues should be addressed. The proposed associations are clearly speculative and suggest avenues for further research. First, cotinine, as an indicator of nicotine exposure, may be a reasonable indicator of nicotine dependence. Consequently, it is intriguing that cessation rates are higher in Whites and Blacks.[21] It is unclear whether Whites are more successful at cessation than Blacks because of a lesser nicotine dependency or other factors such as greater participation in cessation programs. The predictors of these success rates merit further investigation.

Second, higher average cotinine levels in Black smokers correspond with their higher incidence of several tobacco related cancers, particularly among young men.[22] Certainly the overall greater proportion of smokers among Blacks than Whites account for some of this differential, but perhaps not all. The biologic plausibility of such an association remains unclear. Although cocarcinogenic activity has been found for nicotine,[23] it has not been shown for metabolites of nicotine, including cotinine.[24]

In conclusion, considerably higher cotinine levels were observed in Black than in White smokers and this was not explained by reporting bias or nicotine intake differences. The difference in cotinine levels may be due to innate differences between the races in the metabolism or excretion of nicotine or cotinine. The findings may be relevant to understanding racial differences in the risk of nicotine addiction and tobacco-related cancers.

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Apparent Underreporting of Cigarette Consumption among Mexican American Smokers

ELISEO J. PÉREZ-STABLE, MD, BARBARA VANOSS MARÍN, PHD, GERARDO MARÍN, PHD,
DEBRA J. BRODY, MPH, AND NEAL L. BENOWITZ, MD

Abstract: To determine the accuracy of self-report of cigarette consumption among Mexican American smokers, we compared self-reported cigarette use and serum cotinine concentrations in a sample of 547 participants in the Hispanic Health and Nutrition Examination Survey (HHANES). We defined underreporting of cigarette use as a cotinine to cigarette-per-day ratio of $> 0.142\ \mu M/l$ which represented a substantial discrepancy between self-reported consumption and serum cotinine. Of the 98 men and 97 women who reported smoking one to nine cigarettes/day, 20.4 percent and 24.7 percent, respectively, underreported their cigarette consumption. Underreporting was less common among men and women smoking 10 to 19 cigarettes/day (8.3 percent and 10.8 percent, respectively) and 20 or more cigarettes/day (2.2 percent and 2.9 percent, respectively). Comparison of underreporters to other smokers by demographic characteristics within sex and cigarettes/day categories showed no differences. Differences in cotinine metabolism and extremely efficient smoking are alternative explanations that can not be ruled out with these data. We believe, however, that a proportion of Mexican American light smokers may underreport the quantity of cigarettes smoked per day, and may truly be moderate or heavy smokers. (*Am J Public Health* 1990; 80:1057–1061.)

Introduction

Over the past three decades, epidemiological surveys have relied on self-reported smoking behavior to determine current smoking prevalence, and to quantify tobacco consumption in cigarettes per day.[1-3] Because of possible deception in reporting smoking status, biochemical tests to validate self-reported cessation from cigarette smoking have become necessary measures in evaluating programs to help smokers quit.[4] Studies evaluating the relation between biochemical measurements and self-reported cigarette consumption among known smokers indicate that serum levels of nicotine and of its principal metabolite cotinine plateau above 20 cigarettes per day.[5,6] Behavioral factors related to the way a cigarette is smoked may be more important in maintaining a smoker's nicotine level than the actual nicotine delivery of a given cigarette brand as determined by a cigarette smoking machine and reported by the Federal Trade Commission.[7]

Regional and national surveys have consistently shown that Mexican Americans differ in their smoking behavior when compared to Whites who are not Hispanic.[8-13] Men of both groups smoke in similar proportions and smoking rates are higher among White women, but Mexican American smokers report an average of 10 to 12 cigarettes per day compared to 19 to 23 for Whites and 14 to 15 cigarettes per day for Blacks.[13,14] Because the proportion of light smokers among Mexican Americans is substantially greater than among Whites, we hypothesized that underreporting may partly account for this difference.

To compare self-reported cigarette use with a biological marker of smoking behavior, we evaluated the serum cotinine levels in 547 Mexican American smokers who participated in the Hispanic Health and Nutrition Examination Survey (HHANES) in the Southwestern states.

Methods

Southwestern HHANES

The Mexican American portion of HHANES was conducted in the Southwestern states of Arizona, California, Colorado, New Mexico and Texas between 1982–1983 by the National Center for Health Statistics (NCHS). A stratified probability sample of the civilian, noninstitutionalized Mexican American population living in these states was generated using a four-stage process.[15] HHANES included both a household interview and a medical examination, conducted in either Spanish or English. Data on smoking behavior and demographic information were collected. A total of 4,735 Mexican Americans age 20 to 74 years were selected for the survey, with 3,324 (70.2 percent) completing the physical examination portion where blood was drawn. Details of the sample design, operational plan, and quality control procedures are described elsewhere.[15]

The Cotinine Sample

The study population in this report is a subsample of the examined HHANES Mexican American population. Eligibility was based on current smoking status and the availability of 0.5 ml of frozen serum in 1986. Stratifying by sex (male/female) and the number of self-reported cigarettes smoked (1 to 9, 10 to 19, ≥ 20), persons were randomly selected from those with available serum in order to have 90 to 98 subjects per cell. Due to the limited number of women smoking 20 or more cigarettes per day, only 70 persons could be selected for that cell. Table 1 shows the distribution of the cotinine sample in the six cells with the corresponding total number of examined Mexican American HHANES smokers in each cell. The proportion of persons by cell selected from the total sample ranged from 44 percent to 80 percent.

Cotinine Analysis

Measurement of the concentration of cotinine in the serum of persons who reported smoking more than five cigarettes per day was performed using automated capillary gas chromatographic techniques described in detail in other publications.[16,17] Cotinine, principal metabolite of nicotine,

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Address reprint requests to Eliseo J. Pérez-Stable, Division of General Internal Medicine, Department of Medicine, University of California-San Francisco, 400 Parnassus Avenue, Room A-405, San Francisco, CA 94143-0320. Dr. B. Marín and Dr. Benowitz are also with that Department; Dr. G. Marín is with the Department of Psychology, University of San Francisco; Ms. Brody is with the National Center for Health Statistics; and Dr. Benowitz is also with the Division of Clinical Pharmacology and Experimental Therapeutics Medical Service, San Francisco General Hospital Medical Center. This paper, submitted to the Journal June 12, 1989, was revised and accepted for publication January 24, 1990.

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TABLE 1—Demographic Characteristics of Sample Selected for Cotinine Measurements from Mexican American Smokers in Southwest HHANES

	Self-Reported Cigarettes per Day					
	1 to 9		10–19		≥ 20	
	Men	Women	Men	Women	Men	Women
HHANES denominator (n)	221	197	153	123	207	87
cotinine sample (n)	98	97	96	93	93	70
% age (years):						
20–39	62	61	55	47	46	51
40–74	38	39	45	53	54	49
mean age (years)	37.9	37.6	39.6	41.3	43.3	41.6
% with education (years):						
0–11	72	64	68	63	66	61
≥ 12	28	36	31	37	34	39
mean education (years)	7.7	8.9	8.6	86	9.0	9.1
% acculturation tertile						
low	45	31	24	20	32	19
middle	35	34	30	38	37	26
high	20	35	46	42	31	56
% with income						
below poverty	36	31	34	33	32	34
at or above poverty	64	69	66	67	68	66
% with blood drawn:						
in morning	58	58	62	58	63	54
in afternoon	42	42	39	42	37	46
mean cigarettes/day	4.1	4.2	12.7	11.0	24.0	24.3

has a half-life averaging 19 hours, compared to a half-life of two hours for nicotine.[18,19] There are no data on possible ethnic or racial differences in the metabolism of nicotine among habitual smokers.

Excess serum on HHANES participants was stored at the Centers for Disease Control laboratory at a temperature of minus 70 degrees Celsius. Samples were shipped to San Francisco for cotinine assessment on dry ice and thawed prior to analysis. Cotinine analyses were completed within five years of serum collection, and concentrations of cotinine in frozen serum have been found to be stable over at least a five-year period (unpublished data, N.L. Benowitz). Serum cotinine concentration from smokers reporting one to five cigarettes per day was assayed by the same capillary column gas chromatography method, but modified with a sample concentration step to increase sensitivity. Standards of 0.001 (0.2), 0.003 (0.5), 0.006 (1.0), 0.028 (5.0), and 0.057 μM/l (10 ng/ml) were used. The limit of detection was about 0.001 μM/l (0.2 ng/ml). Results from these two methods for measuring cotinine on the same sample are identical.

Based on data from studies[20] conducted with heavy smokers (average of 36 cigarettes per day) who were restricted to 15, 10, and 5 cigarettes per day, a maximum serum cotinine level of 0.142 μM/l (25 ng/ml) per cigarette smoked was achieved by these extremely efficient smokers. This corresponds to an intake of nicotine of approximately 3 mg per cigarette. Thus, we have defined underreporting of self-reported cigarette consumption as a serum cotinine per cigarette value exceeding 0.142 μM/l (25 ng/ml) per cigarette. In support of this cutoff are the data of Shiffman, *et al*,[21] who measured cotinine levels in smokers who habitually smoke no more than five cigarettes per day. The average cotinine level per cigarette smoked was 0.08 μM/l (SD = 0.067) (14.0 ng/ml; SD = 11.8), which is nearly identical to the 0.07 μM/l (SD = 0.031) (12.5 ng/ml; (SD = 5.4) value for more dependent smokers reported by Benowitz and colleagues.[19]

Data Analysis

Data were analyzed using SPSSX.[22] Comparisons of proportions were made with chi squares and means were compared by t test and analysis of variance. An acculturation scale modified from Cuellar and colleagues[23] was used to divide the population into low, middle, and high tertiles for the purpose of these analyses. The poverty threshold defined in 1982 dollars by the Bureau of the Census was used to categorize the sample by income.[24]

Results

The demographic characteristics of the 547 Mexican American smokers are shown in Table 1 stratified by sex and self-reported cigarettes per day. This sample of smokers is not representative of Mexican Americans in the Southwest US because of the criteria used for selection. Light smokers (1–9 cigarettes/day) were younger than moderate (10–19 cigarettes/day) and heavy smokers (≥ 20 cigarettes per day). Acculturation scores were lower among men compared to women for each category of smokers and among light smokers compared to moderate and heavy smokers. Distribution by years of education completed, income below or above the poverty level, and the time blood was drawn were similar by sex and category of smokers.

Data from smokers who underreported cigarette consumption, as defined by a cotinine per cigarette ratio exceeding 0.142 μM/l (25 ng/ml) per reported cigarette, as shown in Table 2. Of the 98 men and 97 women light smokers, 20 (20.4 percent) and 24 (24.7 percent), respectively, exceeded 0.142 μM/l per cigarette with a mean cotinine per cigarette almost twice the threshold. Mean cotinine levels for light smokers were 4.3 times greater for men and 4.9 times greater for women who underreported than among the other smokers. Among moderate smokers the proportion underreporting cigarette consumption decreased to 8.3 percent for men and 10.8 percent for women. Heavy smokers were the least likely to be classified as underreporters with only two men (2.2

TABLE 2—Serum Cotinine in Mexican American Smokers: Underreporters and Other Smokers

	Self-Reported Cigarettes/Day					
	1 to 9		10–19		≥ 20	
	men	women	men	women	men	women
total n	98	97	96	93	93	70
Percent underreporters	20.4	24.7	8.3	10.8	2.2	2.9
Mean cotinine (μM/l)	1.018	1.206	2.055	2.039	2.909	3.108
Mean cotinine/cigarette	0.255	0.270	0.185	0.196	0.145	0.155
Percent other smokers	79.6	75.3	91.7	89.2	97.8	97.1
Mean cotinine (μM/l)	0.238	0.242	0.943	0.774	1.349	1.410
Mean cotinine/cigarette	0.049	0.054	0.073	0.069	0.059	0.064

percent) and two women (2.9 percent). Comparison of the demographic characteristics of the 66 smokers classified as underreporting cigarette consumption to the other smokers by smoker category and sex show no differences by any of the variables examined including acculturation score. None of the 66 smokers classified as underreporters used cigars, pipes, or smokeless tobacco.

Among the underreporting light and moderate smokers, 36 indicated that they smoked a greater number of cigarettes in the past than at the time of the survey. If this number is used as an alternative value for self-reported consumption, then the proportion of underreporters among self-reported light smokers would decrease to 6.1 percent for men and to 15.5 percent for women. A similar decrease in underreporters would occur among moderate smokers to 3.1 percent of men and 7.5 percent of women. None of the four underreporting heavy smokers reported smoking a greater number of cigarettes in the past than at the time of the survey.

In order to quantify the number of cigarettes underreported by these smokers, an average minimum increase in serum cotinine of 0.057 μM/l (10 ng/ml) per cigarette smokes was estimated to occur.[20] A range of underreported cigarettes per day was derived from the expected minimum increase (0.057 μM/l) and the expected maximum (0.142 μM/l) increase in serum cotinine. Among the men and women light smokers, we estimated that they were actually smoking from 3 to 14 and from 4 to 17 more cigarettes per day, respectively. Among moderate smokers the estimated range of additional cigarettes smoked per day was 3 to 25 for men and 4 to 26 for women.

The average serum cotinine of the Mexican American smokers in this sample are shown in Table 3 by sex and smoker category. The overall values for moderate and heavy smokers are somewhat lower than the average level of 1.47 μM/l (259 ng/ml) reported among 450 smokers of 10 or more cigarettes per day who were volunteers at the blood banks in Bergen County, New Jersey (ethnicity not stated, but presumably mostly Whites).[6] Pearson correlations between cotinine levels and self-reported cigarettes per day are weak for moderate and heavy smokers and stronger for light smokers. Analysis of variance showed that serum cotinine increases with number of cigarettes smoked per day ($F(2,545) = 104.7$, $p < .0001$), age ($F(1,432) = 8.5$, $p = .004$), and acculturation level ($F(2,545) = 3.5$, $p = .03$) related. Sex, educational level, poverty status, and time blood was drawn did not have a consistent influence on cotinine concentration.

Discussion

The measurement of cotinine concentration in blood, urine, or saliva has been used predominantly to verify self-reported smoking status among persons claiming to have quit using cigarettes.[25–29] Use of cotinine measurements to evaluate underreporting in the quantity of self-reported cigarettes smoked per day has not been previously conducted. Applying this method to analysis of a sample of HHANES Mexican American smokers indicates that at least 20.4 percent of men and 24.7 percent of women who reported smoking less than 10 cigarettes per day may be underreporting their actual consumption.

TABLE 3—Serum Cotinine (μM/l) by Demographic Characteristics and Cigarette Consumption in HHANES Mexican American Smokers

		Self-Reported Cigarettes/Day					
		1 to 9		10–19		≥ 20	
		men	women	men	women	men	women
total n		98	97	96	93	93	70
Mean cotinine (μM/l)		0.40	0.48	1.03	0.91	1.38	1.46
Correlation to cotinine	r	.51	.50	.25	.20	.19	.25
	p	<.01	<.01	<.01	<.03	<.04	<.02
Age (years)							
20–39		0.37	0.37	1.07	0.84	1.27	1.40
40–74		0.44	0.65	0.99	0.98	1.48	1.52
Acculturation							
low		0.48	0.28	0.97	0.83	1.35	1.38
middle		0.32	0.63	1.02	0.93	1.35	1.17
high		0.35	0.52	1.07	0.93	1.46	1.62

We initiated this research to validate biochemically the finding in the Southwest HHANES (and other surveys) that Mexican Americans are mostly light or moderate smokers. Our findings support an overall lower level of dependence on nicotine as compared to another large community sample of non-Hispanic smokers.[6] However, a subset of those Mexican American smokers who report less than 10 cigarettes per day are more dependent on nicotine than the self-reported number of cigarettes would indicate. If a substantially greater proportion of Mexican American smokers are moderate or heavy smokers, then the related health risks for cardiovascular disease and cancer are greater than that determined by self-report. This could also have implications for planning and conducting smoking cessation interventions among Mexican Americans. The need to intensify ongoing community interventions based on culturally appropriate self-help methods[30] or to complement this with individualized or physician-mediated interventions must be considered since many Mexican Americans may not be light smokers.

The proportion of underreporting among light and moderate smokers was reduced by more than half when the maximum number of cigarettes smoked in the past was used in place of the self-reported number at the time of the survey. This may reflect the desire among many smokers to smoke less and the accurate reporting of past history may actually represent current habits. Regardless, the maximum number of cigarettes smoked per day in the past may be an important additional measure of self-reported smoking behavior among Mexican Americans.

Coultas and colleagues recently found discrepancies between self-reported and validated cigarette smoking in a community survey of New Mexico Hispanics.[31] Their study found that among former smokers older than 18 years of age, the proportion with a salivary cotinine greater than 0.11 μM/l (20 ng/ml) (defined as current smoker) was as high as 21.4 percent. Our study expands on these findings in that we are estimating a similar rate of apparent underreporting in self-reported number of cigarettes consumed among Mexican American light smokers. The substantial level of inconsistencies between the number of self-reported cigarettes smoked and the results of cotinine concentrations may also reflect a tendency among Latinos to give socially desirable responses.[32]

The use of a cotinine per cigarette ratio exceeding 0.142 μM/l (25 ng/ml) as the cutoff to define underreporting is conservative. In another study, nine heavy smokers (average 36 cigarettes per day) were restricted to five cigarettes per day and only two were able to achieve cotinine to cigarette ratios exceeding 0.142 μM/l per cigarette.[19] In contrast, people who are carefully documented as smoking five or fewer cigarettes per day have intakes of nicotine and levels of cotinine per cigarette similar to heavy smokers during unrestricted smoking.[20] Considering these data, we conclude that in setting the criterion at 0.142 μM/l per cigarette we are probably underestimating the prevalence of possible underreporting.

It is possible that some underreporters in HHANES were extraordinarily efficient in smoking cigarettes, but this is unlikely to fully explain our results given that heavy smokers with restricted access to cigarettes were unable to achieve comparable cotinine levels. Another possible alternative explanation for our findings involves ethnic or racial differences in the metabolism of nicotine and clearance of cotinine. Wagenknecht and colleagues[33] have proposed that higher serum cotinine levels among Black compared to White smokers (despite fewer self-reported cigarettes consumed per day) were due to racial differences in the metabolism of nicotine and not to a reporting bias. If Mexican Americans metabolize nicotine more slowly, our results would be partly accounted for without underreporting. Alternatively, light and moderate smokers for any ethnic group may have a much slower metabolism of nicotine or a slower clearance of cotinine than the average habitual smoker.

Several limitations in this study need to be considered. Although HHANES results are generalizable to Mexican Americans in the Southwestern states, our study selected smokers based on availability of frozen serum and may not apply to all smokers. Given that 42 percent of HHANES Mexican American smokers reported smoking less than 10 cigarettes per day, the highest estimates of underreporting apply to a substantial proportion of this population. However, it is possible that if smokers had been informed that a biochemical validation test would be conducted, underreporting would be less frequent. The HHANES Puerto Rican and Cuban American samples were not evaluated in this study, but the proportion of light smokers in those Latino subgroups is less than among Mexican Americans, and thus underreporting may be less common. Finally, our observations in Mexican Americans may be a phenomenon of all light cigarette smokers' self-reporting on quantity independent of ethnicity. In fact, Warner[34] has suggested that survey reports of cigarette consumption underestimate consumption estimates based on production and sales. A more recent comparison concluded that there was no apparent increase in underreporting cigarette smoking in surveys since 1975.[35] The magnitude of underreporting is greater among light smokers, and thus studies using cotinine measurements and applying the method described in this paper may be more important in these populations.

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NIH Consensus Development Conference Announced on Hyperparathyroidism

Hyperparathyroidism is increasingly being recognized in asymptomatic patients, as a result of widespread use of multiphasic screening tests that lead to detection of hypercalcemia. Physicians are often uncertain about the diagnosis and management of patients with subtle or absent signs and symptoms but with a clear biochemical diagnosis of hyperparathyroidism. Especially difficult are decisions about indications for surgery and how patients should be monitored to detect silent organ damage, particularly progressive bone loss.

Because of these issues, the National Institute of Diabetes and Digestive and Kidney Diseases and the Office of Medical Applications of Research at the National Institutes of Health will co-sponsor a consensus development conference on Diagnosis and Management of Asymptomatic Primary Hyperparathyroidism. The meeting will be held October 29–31 at NIH, Masur Auditorium, in Bethesda, MD.

To register for this conference or to obtain further details, contact: Conference Registrar, Prospect Associates, Suite 500, 1801 Rockville Pike, Rockville, MD 20852. Tel: (301) 468-MEET.

Demographic Characteristics, Risk Behaviors, and HIV Seroprevalence among Intravenous Drug Users by Site of Contact: Results from a Community-wide HIV Surveillance Project

JANE MCCUSKER, MD, DRPH, BERYL KOBLIN, PHD, BENJAMIN F. LEWIS, EDD, AND JOHN SULLIVAN, MD

Abstract: We investigated differences in behaviors important for human immunodeficiency virus (HIV) transmission and HIV antibody status among 927 recent needle users enrolled in a multi-site HIV surveillance project in Worcester, Massachusetts. Subjects were enrolled at drug abuse treatment centers, other clinical sites, and a men's jail. Subjects at drug treatment centers reported less risky injection practices unexplained by demographic variables. Risky sexual practices were in general reported more frequently by men at the jail than men at other sites. However, HIV status showed little relation to enrollment site. These results have implications both for targeting of acquired immunodeficiency syndrome (AIDS) prevention programs to needle users not in drug abuse treatment and for potential selection bias in studies of intravenous drug users. (*Am J Public Health* 1990; 80:1062–1067.)

Introduction

Intravenous drug users (IVDUs) who share injecting equipment play an important role in the transmission of the human immunodeficiency virus type 1 (HIV-1), the causative agent of the acquired immunodeficiency syndrome (AIDS).[1] There is some evidence that IVDUs are not a homogeneous group, and that sub-populations exist with different risks of infection with HIV. Watters and Cheng described two sub-populations of IVDUs in San Francisco: the first was in somewhat regular contact with drug abuse treatment programs, while the second, contacted on the street and in jail, did not interact routinely with drug treatment.[2] Distinction between sub-populations of IVDUs is important both for program planners who may need to target programs differently for different sub-populations, as well as for epidemiologists and other researchers who need to understand the types of selection bias introduced by studying a particular sub-population.

HIV infection is a function both of risky behavior and of the probability that persons with whom the behavior is practiced are infected. Seroprevalence differences may not reflect differences in risky behavior in areas where HIV has been introduced relatively recently. This report investigates differences in risky behaviors and HIV seroprevalence in IVDUs enrolled at multiple sites in a community-wide AIDS prevention program. The data were collected as part of a surveillance system which monitors HIV infection and related behaviors among IVDUs and their sexual contacts in Worcester, Massachusetts.[3] Worcester has an IVDU population estimated in 1988 at about 4,000 and from 1983–86 was the site of a significant epidemic of delta hepatitis.[4] Since 1987, public health interventions targeted at IVDUs which build upon and are coordinated with the ongoing hepatitis B prevention program have been collaboratively planned by members of the Worcester AIDS Consortium, including the city health department, drug abuse treatment facilities, correctional facilities, community health centers, and support and advocacy programs for persons with HIV infection.

Methods

Study enrollment began at the men's county jail in September 1987, followed by the city health department's hepatitis B and HIV clinic and one community health center in December 1987, the three drug abuse treatment centers in February 1988, and the second community health center and a clinic for sexually transmitted diseases run by the State Department of Public Health in April 1988. Interviews completed by the end of December 1988 are included in this study.

Interviews with a short, standardized encounter form are conducted by project staff who are not involved in the care or treatment of the individual. At the three drug abuse treatment centers (a therapeutic community, an inpatient 21-day methadone detoxification facility, and an outpatient clinic providing methadone services and drug-free counseling), the encounter form is administered routinely at admission. At one of the community health centers it is administered routinely to all high-risk clients who are referred for HIV counseling. At those sites where use of the encounter form is part of the client's record, consent is obtained for release of encounter form data to the study. At all other sites, consent is obtained prior to administration of the encounter form. At the men's jail an AIDS educational session, at which attendance is voluntary, is given once a week by a team from the City Department of Public Health.* At the end of the session, the inmates are informed about the study and asked to participate.

Information collected in the encounter interview includes sociodemographic variables, drug use and social behaviors, and results of previous HIV antibody testing (see appendix). Subjects are asked about relevant behavior during their lifetime and during the most recent period of at least one week and not more than three months of "free living," when not in any institutional setting. The main drug use and sexual behaviors reported in this paper are those reported for this "risk period" and are referred to subsequently as "recent" behaviors.

Address reprint request to Jane McCusker, MD, DrPH, Professor of Epidemiology, 406 Arnold House, School of Public Health, University of Massachusetts, Amherst, MA 01003. Dr. Koblin is also at the School of Public Health, University of Massachusetts-Amherst; Dr. Lewis is with Spectrum House Inc., Westboro, MA; Dr. Sullivan is with the Department of Pediatrics, University of Massachusetts Medical Center-Worcester. This paper, submitted to the Journal July 28, 1989, was revised and accepted for publication December 8, 1989.

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*Noone S, Birch F, Sereti, Santana L, Patashnik B, Murphy B, Lewis B, Brady P, Sullivan J: A comprehensive prison program for AIDS risk reduction. Abstracts of the IV International Conference on AIDS, Stockholm, June 1988.

At all sites, voluntary HIV antibody testing in conjunction with pre-test counseling is available following the interview. Initial serological screening is carried out using Food and Drug Administration (FDA)-approved commercial ELISA (enzyme-linked immunosorbent assay) kits. Each sample which tests positive by the ELISA is confirmed using a Western blot test.**[7]

In this report we use only data from the first contact of each individual with the Worcester program. Cross tabulations, stratified by sex, were used to assess between-site differences in demographic variables, drug and sexual behaviors, and HIV status.

In order to assess site-specific differences controlling for demographic variables, logistic regression modeling[6] was performed on HIV antibody status and four recent behaviors: sharing of injection equipment; use of bleach to clean injection equipment by those who reported sharing; sexual contact with two or more partners (for females, male partners only were considered); and use of condoms during sex among those with two or more sexual partners. All behaviors were dichotomized (yes or no).

Interpretation of the current HIV antibody test results is complicated by the tendency for those who had previously been tested not to be retested, particularly if they had a positive test result. Therefore, we chose to use the cumulative test results of those ever tested, derived from the results of testing in the Worcester program, and self-reported results of previous HIV antibody tests for individuals not tested in the Worcester program. Separate regression models were run for males and females. Goodness of fit of the logistic models was assessed using the Hosmer-Lemeshow statistic.[6]

Results

Participation rates were as follows: about 50 percent of those attending the educational sessions at the jail; about 85 percent of clinic patients referred for counseling; and over 90 percent of those admitted to the drug treatment centers. The participation rate at the jail is an underestimate, as many prisoners were observed to attend two or more of the sessions before deciding to participate. In the period ending December 31, 1988, 2,174 individuals had been enrolled in the project, 927 (43 percent) of whom reported recent ("risk period") needle use.

Characteristics of recent needle users by site of initial study enrollment are shown in Table 1 (males) and Table 2 (females). On transsexual individual has been omitted from analysis. Clinic sites have been grouped: most were enrolled at health department clinics.

Significant differences between the enrollment sites were found for almost all demographic variables, both among males and females. Among males, the youngest needle users were enrolled at the jail. In both sexes the oldest needle users and those who had been injecting for the longest time were enrolled at the outpatient drug treatment center. The drug abuse treatment centers attracted lower proportions of racial and ethnic minority members, and higher proportions of high school graduates. Those enrolled in the residential drug abuse treatment centers were more often resident outside Worcester than those at the outpatient sites.

Drug use behaviors also differed significantly by site of enrollment. Needle users entering drug abuse treatment reported the highest frequency of injection but the lowest proportion of sharing and sharers were more likely to have used bleach recently to disinfect their injection equipment. Among males, several other risky drug behaviors were also reported less frequently at drug treatment centers: visiting a "shooting gallery" and sharing injection equipment in New York City.

Less marked differences were found in sexual behavior by enrollment site. Among males, as the percentage reporting homosexual partners were very low, these have been combined with heterosexual partners for these analyses. Men at the jail were more likely to report multiple sex partners during the "risk period," and those with multiple partners were less likely to have used condoms.

Overall, 60 percent of males and 37 percent of females were tested for HIV antibody in the program, with lower percentages tested at the drug treatment centers. An additional 20 percent of males and 33 percent of females had been tested prior to enrollment in the Worcester program. The cumulative percentage ever reporting a positive test result was slightly lower at the inpatient and residential drug abuse treatment sites than at the other sites.

Logistic regression modeling controlling for demographic variables indicated that the odds of not sharing injection equipment were higher at all drug abuse treatment sites in comparison with the clinics (Table 3). In comparison with men at the jail, men at all three drug abuse treatment sites were less likely to share and confidence intervals (now shown) excluded unity. In both sexes, bleach use among needle sharers was higher in all drug abuse treatment center groups than the clinic group.

Sexual behaviors in the drug treatment groups differed from those at the clinics but the confidence intervals included unity (Table 3). However, men at the jail were more likely than men entering drug abuse treatment to report two or more sexual partners; among men with multiple partners, those at the detoxification center were more likely to use condoms than men at the jail and these confidence intervals (not shown) excluded unity.

In contrast with the between-site differences in drug and sexual behaviors, cumulative HIV status differed relatively little by enrollment site (Table 3). In an effort to explain the lack of congruence between the serological data and the risk behaviors, we investigated whether there were differences in risk behaviors between those ever and never tested at the drug abuse treatment sites (at the other sites too few had never been tested). We also examined the relation between risk behaviors and serological status among those who had been tested, stratifying by site of enrollment. No significant associations or consistent trends were found, although small numbers of seropositives at some sites limited the power of these analyses.

Discussion

We found significant differences by enrollment site in demographic characteristics and drug use behaviors of recent needle users. Needle users entering drug abuse treatment tend to be of higher socioeconomic status, and include fewer racial-ethnic minority members than those at other sites. Among the drug abuse treatment facilities, those offering

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**Alexander SS, Chang-Chi T, Ting RL, Bodman AJ: Western blot analysis of human T-cell lymphotropic virus III proteins using an avidinbiotin system. Abstracts of the Annual Meeting of the American Society for Microbiology, 1985 (March); 297.

TABLE 1—Demographic Variables, Behaviors, and HIV Antibody Status of Male Recent Needle Users (n = 678), by Enrollment Site

	Drug Treatment Centers			Other Sites		
Variables	TC (n = 66) %	Detox (n = 211) %	OP (n = 113) %	Clinics (n = 33) %	Jail (n = 255) %	Total (n = 678) %
Age 30 years or over	64	62	80	70	44	59
Race						
Hispanic	5	5	19	18	29	17
Black	9	8	4	18	8	8
Other	86	87	77	64	63	75
High school graduate	84	74	75	64	53	67
Married	18	31	48	45	56	43
Worcester resident	19	17	64	76	64	46
Prior drug treatment	44	38	28	27	32	34
Prior jail	64	44	55	67	83	64
Injected >5 years	67	61	89	67	56	64
Drugs injected (ever)						
heroin	94	96	100	82	84	91
cocaine	94	89	81	97	93	90
Recent Behaviors						
Daily needle use	75	90	95	50	67	79
Shared equipment	70	61	65	81	85	73
Total sex partners						
None	24	16	14	27	11	15
One	41	48	65	36	43	48
2 or more	35	36	21	36	46	37
Recent Drug Behaviors Among Sharers Only						
	(n = 46)	(n = 129)	(n = 73)	(n = 26)	(n = 215)	(n = 489)
Frequency of sharing						
daily	13	27	38	33	55	40
1–6/week	52	33	48	44	25	34
<1/week	35	40	14	22	21	26
Cleaned with bleach	59	67	66	46	43	55
Shared in NYC	13	2	4	15	16	10
Visited a shooting gallery	19	20	17	38	32	26
Recent Sexual Behaviors if Multiple Partners						
	(n = 22)	(n = 75)	(n = 24)	(n = 12)	(n = 112)	(n = 245)
Used condoms	5	32	25	27	12	19
Sex with prostitute	32	29	27	25	25	27
HIV Antibody Tests						
	(n = 66)	(n = 211)	(n = 113)	(n = 33)	(n = 255)	(n = 678)
Currently tested	26	49	6	88	98	60
Positive result	0	9	29	21	23	18
Ever tested	74	74	51	97	98	80
Positive result	6	15	24	22	23	19

TC = Therapeutic Community;
Detox = Detoxification Facility;
OP = Outpatient Services

residential and inpatient services attract more young, unmarried clients from outside Worcester than the outpatient clinic. Clients entering outpatient drug abuse treatment are older and have longer injection histories than those entering residential drug abuse treatment, in part because most receive methadone services which require the client to have used heroin for at least one year prior to entry into treatment.

Our results suggest that needle users entering treatment have significantly lower levels of risky drug behaviors, including sharing of injection equipment and not using bleach for disinfection, than those at other sites. In spite of more frequent needle use among those entering drug abuse treatment, safer practices appear to be followed.

Among men, those at the jail report multiple sexual partners more frequently than those at the drug abuse treatment centers, and are less likely to use condoms than those at two of the drug treatment sites. In spite of these behavioral differences, there is little difference in HIV status, but testing was not universal.

We were not able to explain the lack of congruence between the serological data and the risk behaviors. Selection bias (selective testing at the drug abuse treatment sites of those with more risky behaviors) did not explain this finding. It seems more likely that the explanation lies in the cross-sectional study design and the use of prevalent rather than incident infection. For many study subjects, HIV infection may have occurred prior to the recent "risk period" for which risk behaviors were measured. For example, in a study of homosexually active males reported by our group, both prior and recent frequently of risky behavior were independently associated with HIV seroprevalence.[7] We were not able to carry out similar analyses on the present study population, as data were not collected on previous risk behaviors.

TABLE 2—Demographic Variables, Behaviors, and HIV Antibody Status of Female Recent Needle Users (n = 248), by Enrollment Site

	Drug treatment centers			Other sites	
Variables	TC (n = 25) %	Detox (n = 103) %	OP (n = 92) %	Clinics (n = 28) %	Total (n = 248) %
Age 30 years or over	40	40	61	36	47
Race					
Hispanic	16	8	10	21	11
Black	8	2	1	18	4
Other	76	90	89	61	85
High school graduate	72	65	68	39	64
Married	8	36	29	32	30
Worcester resident	20	28	68	79	52
Prior drug treatment	40	42	37	36	39
Prior jail	77	34	48	50	45
Injected >5 years	57	61	79	43	65
Drugs injected (ever)					
heroin	100	96	99	89	97
cocaine	100	87	84	86	87
Recent behaviors					
Daily needle use	80	96	94	68	90
Shared equipment	68	58	65	86	65
Male sex partners					
None	20	16	15	22	17
One	32	44	47	44	44
2 or more	48	39	38	33	39
Recent Drug Behaviors among Sharers					
	(n = 17)	(n = 59)	(n = 60)	(n = 24)	(n = 160)
Frequency of sharing					
daily	25	55	41	54	47
1–6/week	56	17	32	25	28
<1/week	19	28	27	21	25
Cleaned with bleach	71	74	71	50	69
Shared in NYC	18	8	8	0	8
Visited a shooting gallery	29	24	27	21	25
Recent Sexual Behaviors if Multiple Partners					
	(n = 12)	(n = 38)	(n = 35)	(n = 9)	(n = 94)
Used condoms	58	62	56	22	55
Prostitution	100	68	79	33	73
HIV antibody tests					
	(n = 25)	(n = 103)	(n = 92)	(n = 28)	(n = 248)
Currently tested	8	51	9	89	37
Positive result	50	17	13	32	22
Ever tested	56	79	55	96	70
Positive result	21	25	37	33	29

TC = Therapeutic Community;
Detox = Detoxification Facility;
OP = Outpatient Services

A second possibility is that previous HIV antibody testing may have affected recent risk behavior. Again, without information on previous behaviors, we were not able to assess this hypothesis.

A third possibility is that needle users who enter treatment represent a sub-population which is particularly motivated to reduce their risk of AIDS. Although they report a high frequency of needle use, they may have modified risk behaviors prior to entering treatment.

Reports having highlighted the significance of the recent epidemic of "crack" cocaine use for HIV transmission, in which sexual practices rather than IV drug use appear to be responsible for HIV transmission.[1] In March 1989, we began to collect information on "crack" use; about one-fifth of recent needle users have smoked "crack" although we have no information on frequency. Drug use rather than sexual behaviors appear to be associated with HIV seroprevalence in this study population, although these behaviors tend to be associated (unpublished data).

Demographic and behavioral differences in sub-populations of needle users have been reported by other researchers, although none have information on drug use and sexual behaviors from as many different enrollment sites as were possible in this study. Several studies from the United Kingdom have found that drug users in treatment were older, had used drugs for longer, and showed greater reductions in risk behavior.[8–11,***] Results of studies from different parts of the US, however, show inconsistent differences by site of enrollment.[2,12†,††,†††]

Several limitations of this research should be considered, including selection and measurement biases. Although the multi-site enrollment in this study allows some examination of possible selection bias, it does not eliminate such bias. Of particular concern is selection bias at the non-drug clinics and at the jail; at these sites, the HIV antibody testing may have attracted many of the participants and others have found that higher risk needle users tend to self-select for HIV testing in prisons.[‡,‡‡]

Measurement bias was avoided to some extent by having the interviews done by staff who were not involved in the individual's care or treatment. Nevertheless, study participants may have misrepresented their drug behaviors in efforts to impress the staff, or to obtain higher doses of methadone at drug abuse treatment sites. Factors such as social desirability and prior drug use by the interviewer can affect validity.[13,14] Self-reports of drug use may differ from "official" records, such as addict registers or hospital charts.[15–17] Self-reports of sexual behavior are of undetermined reliability and validity; this problem has been examined in homosexual males,[18] but has received little attention among IV drug users.

The demographic differences between needle users by enrollment site are cause for concern; Blacks and Hispanics who are at highest risk of HIV infection[19] are underrepresented in the sub-populations entering treatment.[20] Female needle users are also underrepresented at the inpatient and residential drug abuse treatment centers. Black women of

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TABLE 3—Multivariate Odds Ratios* (OR) and 95% Confidence Intervals (CI) for Drug and Sexual Behaviors and HIV Antibody Status by Enrollment Site among Male (M) and Female (F) Recent Needle Users

Variables	n	Drug Treatment Centers			Other sites		Goodness-of-Fit p-value
		TC	Detox	OP	Clinics	Jail	
Drug behavior							
Never share							
M OR	653	1.66	2.64	2.44	1.00	0.73	
CI		0.56–4.91	0.999–6.95	0.91–6.53		0.28–1.91	0.55
F OR	242	3.57	6.71	5.24	1.00	—	
CI		0.81–15.77	1.84–24.49	1.44–19.07			0.82
Clean with bleach**							
M OR	470	3.17	5.07	2.71	1.00	1.32	
CI		1.08–9.33	1.96–13.12	1.03–7.12		0.55–3.13	0.66
F OR	155	4.21	4.67	3.38	1.00	—	
CI		0.95–18.67	1.43–15.25	1.14–10.08			0.99
Sexual behavior							
<2 partners							
M OR	638	1.37	1.10	2.07	1.00	0.66	
CI		0.54–3.52	0.49–2.47	0.88–4.89		0.3–1.43	0.65
F OR	236	0.51	0.66	0.84	1.00	—	
CI		0.15–1.76	0.24–1.83	0.31–2.26			0.93
Use condoms***							
M OR	236	0.14	1.23	0.86	1.00	0.31	
CI		0.01–1.7	0.26–5.7	0.16–4.45		0.07–1.43	0.47
F OR	89	3.74	4.40	4.26	1.00	—	
CI		0.44–31.8	0.7–27.8	0.71–25.5			0.24
HIV positive							
M OR	530	0.43	1.10	1.31	1.00	1.22	
CI		0.09–1.94	0.39–3.15	0.44–3.93		0.48–3.15	0.47
F OR	169	0.55	0.58	1.32	1.00	—	
CI		0.11–2.81	0.19–1.77	0.44–3.96			0.55

*Controlling for age, race, marital status, education, and residence.
**Among subjects who share.
***Among subjects with multiple partners.

lower socioeconomic status are least likely to enter drug abuse treatment programs, and may only do so after exhausting informal resources.[21] Outpatient programs which offer child care are needed; methadone maintenance programs can be very effective, but may need to adopt a more lenient approach in order to keep clients in treatment.[22]

Our study has implications both for the conduct of AIDS prevention programs and for research. AIDS prevention programs need to target sub-populations of needle users with the most risky behaviors, particularly those not currently in treatment.‡‡‡ Incarcerated needle users are an important and very problematic group for prevention programs.[23,24]

Continued monitoring of IVDUs for HIV seroprevalence is important to identify high-risk sub-populations, to appropriately target prevention programs, and to evaluate the effectiveness of those programs. Samples of IVDUs entering drug treatment are often used for monitoring HIV exposure, partly because of their accessibility, and partly because the period before entering drug treatment is said to be characterized by a relatively high frequency of drug injection, and unsafe injection practices.[25] Although our results support higher frequency of drug injection in this sub-population, they do not support less safe injection practices. Use of data from drug abuse treatment programs for monitoring HIV exposure should not be adopted without further critical examination of the potential biases involved; data from drug users enrolled at different sites should not be pooled unless they have first been examined separately by site.

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APPENDIX
Description of Study Variables

- Demographics
  - Age (years)
    - Sex (male; female; transsexual)
  - Race (Hispanic; black, non-Hispanic; white, non-Hispanic; Asian or Pacific islander; Indian/native American; other).
  - Education: high school graduate or general education diploma (yes; no)
  - Residence in city of Worcester (yes; no).
- Prior experience
  - Previously in jail (yes; no).
  - Previously in drug abuse treatment, inpatient or outpatient (yes; no).
- Drug use history
  - Ever injected drugs, intravenously or subcutaneously (yes; no).
  - Ever injected heroin (yes; no).
  - Ever injected cocaine (yes; no).
  - Injected drugs during the "risk period" (yes; no).
- Drug use during "risk period"
  - Frequency of injection (more than once/day; once/day; 3–6 times/week; 1–2 times/week; 1–3 times/month; less than once/month).
  - Frequency of sharing needles, i.e., injecting with needles someone else has already used (once/day; 3–6 times a week; 1–2 times/week; 1–3 times/month; less than once/month).
  - If sharing reported, was bleach ever used to disinfect "works" (yes; no).
  - Sharing in a shooting gallery, i.e., a place where you pay with money or drugs to get in or to get high (yes; no).
  - Sharing needles in New York City (yes; no).
- Sexual behavior during "risk period"
  - Number of female sexual partners (none; one; 2–9, 10–19; 20–49; 50 or more).
  - Number of male sexual partners (none; one; 2–9; 10–19; 20–49; 50 or more).
  - Sexual contact with someone you knew to have used needles since 1981 (yes; no).
  - Received money or drugs in exchange for sex (yes; no).
  - Sexual contact with a prostitute, i.e., someone who gets paid for sex with money or drugs (yes; no).
  - Ever used condom during sex (yes; no).
- HIV antibody testing
  - Ever tested for HIV antibody, including current testing (yes; no).
  - If ever tested, result (positive; negative; equivocal; unknown).
  - Currently tested for HIV antibody, i.e., within one day of encounter interview at non-drug treatment sites, within 30 days of interview at the detoxification and the outpatient drug treatment facility, and within 45 days of interview at the residential drug treatment facility (yes; no). If currently tested, result (positive; negative; equivocal; unknown).

Joint US–Canadian Conference to Focus on Diabetes among Native Indians

"What Makes a Model Community Diabetes Program for American Indians Successful?" That will be the theme of a joint US—Canadian conference titled Diabetes and Native Peoples: International Issues in Education, Treatment, and Prevention, to be held November 7-9, in Minneapolis, MN. Sponsors include the Native American Research and Training Center (NARTC), Indian Health Service, Medical Services Branch—Health and Welfare Canada, American Diabetes Association, and the Canadian Diabetes Association.

This international conference will feature speakers from reservation communities and hospitals throughout Canada and the US, and will address common problems in establishing effective programs and providing care to Indian peoples with diabetes. Conferees will discuss development and implementation of model community diabetes programs. Standards of care and of health education recommended for Native peoples with diabetes also will be reviewed and discussed at the conference.

Continuing Education credit will be offered for physicians, nurses, and pharmacists. A $50 registration fee is required and covers the cost of the banquet dinner, Pow-Wow, and continuing education units. For further information, write or call: (USA), Dr. Robert Young, NARTC, 1642 E. Heler St., Tucson, AZ 87519, (602) 621-5560. (Canada) Virginia Toulouse, Assembly of First Nations—Diabetes Conference, 47 Clarence St., 3rd Floor, Atrium Building, Ottawa, Ontario K1N 9K1, (613) 236-0673.

Death Resulting from Motor Vehicle Immersions: The Nature of the Injuries, Personal and Environmental Contributing Factors, and Potential Interventions

GAREN J. WINTEMUTE, MD, MPH, JESS F. KRAUS, MPH, PHD, STEPHEN P. TERET, JD, MPH,
AND MONA A. WRIGHT, BS

Abstract: We present an epidemiologic characterization of deaths from motor vehicle immersions, based on 77 deaths in 63 motor vehicle immersions in Sacramento County, CA, during 1974–85. All persons were autopsied; all but one of the deaths were due to drowning. Average annual mortality rates per million person years were 12 for males, four for females, 30 for Hispanics, six for White non-Hispanics, Blacks and Asians. Seventy-one percent of drivers and 60 percent of passengers had a blood alcohol concentration ≥22 mmol/L.

Most cases (57 percent) had an Injury Severity Score of 1 (minor injury) or 0 (no injury). Alcohol use was associated with higher Injury Severity Scores. Road curvature of 20° or greater was far more common at crash sites than at matched control sites one mile away(OR = 6.57, 95% CI = 2.93, 14.71). Guard rail placement along highly curved sections of roadway may be an effective preventive measure. (*Am J Public Health* 1990; 80:1068–1070.)

Introduction

Each year there are approximately 350 deaths in the United States resulting from motor vehicle immersions (unpublished data, Fatal Accident Reporting System, 1988). High motor vehicle-related drowning rates have been noted previously in places with many inland waterways such as Florida and Louisiana.[1] In Sacramento County, California, site of a large river delta and the location of this study, autopsy-confirmed drownings from motor vehicle immersions are more common than drownings from boating incidents (unpublished data, The Sacramento Drowning Study, 1987). To our knowledge, the nature and epidemiology of these deaths have not been described.

This study therefore sought answers to the following questions. Are deaths due to motor vehicle immersion actually drownings, or are they due to biomechanical trauma resulting from the crash event itself? By convention all such deaths have been classified as motor vehicle deaths, rather than drownings, since the adoption of the fifth revision of the International List of Causes of Death in 1939. What are the personal and environmental contributing factors for these deaths? What countermeasures are available and likely to be effective?

Sacramento County had 783,381 residents in 1980. The southwestern portion of the county is a river delta. Roads in this area are generally built on levees, some 30 feet above river level. These roads are two lanes wide, with lane widths of 10–12 feet, and have narrow shoulders. The roads are level except for the short distances needed to mount a levee; curves are generally not banked. We observed that speeds of travel commonly exceed 55 mph on major levee roads. In other rural portions of the county, roads may be built next to irrigation canals or other waterways.

Methods

The study period was 1974–85. Cases were identified through a register maintained by the coroner's office, which lists both the anatomical and external causes of death. Cases were defined as persons, regardless of their cause of death at autopsy, who were motor vehicle occupants and who entered the water by means of a motor vehicle immersion. We reviewed coroner's and police reports and interviewed investigative personnel. We also reviewed coroner's records for all motor vehicle deaths occurring in the county for 1980–85, but found no additional cases.

All cases were autopsied. Causes of death were abstracted directly from the autopsy report. Analyses pertaining to blood alcohol concentration (BAC) were restricted to cases in which death occurred within six hours of immersion, and blood sampling occurred within 24 hours of death. These criteria avoid spuriously low values resulting from post mortem sampling after prolonged survival, and spuriously high values resulting from putrefaction.[2]

Traumatic injuries were scored for severity using the Abbreviated Injury Scale (AIS), which assigns to individual injuries a numerical score between 1 (mild) and 6 (unsurvivable).[3] Injury Severity Scores (ISS) were computed.[4] As used in this article, the term "head injury" includes injury to the external soft tissues of the head and face, such as lacerations and abrasions. In calculating Injury Severity Scores, however, these superficial head injuries were coded as "External" injuries as required by standard scoring procedures.

Following the case-control method developed by Wright and Robertson,[5] each crash site (defined as the point at which the vehicle left the roadway) was compared with a point one mile distant, on the same road except as noted below, in the direction from which the vehicle had come. When the path of travel could not be reconstructed with certainty because of an intersection within one mile of the crash site, preference was given first to arterial rather than tributary roads; when the choice involved two roads of the same type, preference was given to the road adjacent to the water. Eleven of 63 immersion events were excluded from this analysis (path of travel uncertain, three cases; vehicle traveled less than one mile prior to immersion, three cases; crash occurred on private or restricted roadway and the investigators could not gain access, two cases; other, three cases). We limited the

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Address reprint requests to Garen J. Wintemute, MD, MPH, Associate Professor, Department of Family Practice, University of California-Davis Medical Center, 2221 Stockton Blvd., Rm 2111, Sacramento, CA 95817. Ms. Wright is also with the Department of Family Practice, UC Davis; Dr. Kraus is Professor of Epidemiology, UCLA School of Public Health; Mr. Teret is Associate Professor, Department of Health Policy & Management, Johns Hopkins School of Hygiene and Public Health. This paper, submitted to the Journal November 9, 1989, was revised and accepted for publication February 12, 1990.

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crash site—control site comparison to road curvature, determined by the middle ordinate method.[5] Curvature was measured at 100 foot intervals for 500 feet in either direction from the point at which the vehicle left the roadway. Gradient and banking, evaluated in Wright and Robertson's earlier work, were each present in only two of the sites we studied.

Using our case identification methods as a "gold standard" procedure for crash site identification, we calculated the sensitivity and specificity of various minimum-curvature criteria as screening tests for identifying known crash sites. Sensitivity was defined as the number of known crash sites identified divided by the total number of known crash sites. Specificity was derived in an analogous manner.

We also inventoried risk-reduction features at crash sites, such as warning signs and guard rails, to learn whether post-crash modifications had been made. We used each crash site as its own historical control, comparing the detailed written and pictorial description in the earlier police reports with our observations in 1987–88. This analysis was limited to the 34 cases for which detailed police reports were available.

Average annual mortality rates were calculated based on place of occurrence, using Sacramento County data from the 1980 US Census to approximate a mid-interval population. All denominators are age-, race-, and gender-specific as appropriate. Rates are rounded.

Confidence intervals were calculated by the exact binomial method using Confidence Interval Analysis software.[7] Other analyses were performed with PC-SAS.

Results

There were 78 deaths identified, but one was excluded as the coroner's record could not be located. The 77 remaining deaths resulted from 63 motor vehicle immersions, all single vehicle events, of which seven led to multiple fatalities. Twenty-five immersions also involved a total of 37 vehicle occupants who survived. (Further information on survivors was not available.)

A car was involved in 65 deaths, a truck in 11, and a motorcycle in one. Fifty persons were drivers, and 27 were passengers. Three deaths were specified as job-related. Seventy-five deaths were classified by the coroner as unintentional, one as suicidal, and one as of undetermined intent.

In all but one fatality, drowning was reported as the sole cause of death, or drowning and one or more traumatic injuries were listed as multiple causes of death. The cause of death for the remaining case was "craniocerebral trauma with possible drowning."

The average mortality rate was eight per million person years. Cases ranged in age from seven months to 73 years; 38 were age 15–34; 57 cases were male. Mortality rates were 12 for males and four for females, per million person years.

The mortality rate for Hispanics was five times those for White non-Hispanics, Blacks, and Asians (30 for Hispanics, six for the other groups, per million person years). Hispanics accounted for 36 percent of these deaths, but made up only 9 percent of the county's population in 1980. This difference was not due to a disproportionate number of nonresidents among Hispanic cases. Sixty-three percent of Hispanic cases, and of all cases, lived in the county. While immersions involving any Hispanic deaths were more likely than others to result in multiple fatalities (OR = 7.5, 95% CI = 1.6, 35.3), this difference did not fully explain the high Hispanic mortality rate. The fatal immersion event rate was also higher for Hispanics than for non-Hispanics (20 and six per million person years, respectively).

Forty deaths occurred on Saturday or Sunday, twice the number predicted by the hypothesis of equal occurrence throughout the week ($\chi^2 = 17.19$, df = 6, $p < .01$). There were no significant differences in incidence by time of day.

A blood alcohol concentration (BAC) was determined in 75 cases; the specified eligibility criteria were met in 56. Five cases were children under age 15, none of whom had a positive BAC. Among older persons, 74 percent of drivers and 73 percent of passengers had a positive blood alcohol concentration; 71 percent of drivers and 60 percent of passengers had a BAC $\geq$ 22 mmol/L.

Serious biomechanical trauma was unusual (Table 1). Most persons had an Injury Severity Score of 1 (minor injury) or 0 (no injury). Fifty-one cases sustained a head injury, but 26 of these were AIS 1 injuries. Alcohol use was associated with higher Injury Severity Scores. Among cases meeting the alcohol sampling criteria, 15 of 18 cases with a score $\geq$ 10 had a BAC $\geq$ 11 mmol/L, as opposed to 23 of 36 cases with an ISS of 0 or 1 (OR = 2.83, 95% CI 2.05, 3.89).

Post-event interventions were uncommon. Only four cases involved immersion times of 30 minutes or less. Three of these four people, and 11 of all 77 cases, were given emergency care after retrieval from the water. One person survived long enough to be admitted to a hospital.

There were large differences in road curvature between crash and control sites. Crash sites had a median curvature of 19° over 1000 feet; the median curvature for control sites was 8° (difference = 11°, approx 95% CI = 2°, 18°). The differences in mean curvature were greatest over the 500 feet approaching the point where the vehicle left the roadway (Figure 1). Crash sites were far more likely than control sites to involve a curvature of 20° or greater (OR = 6.57; 95% CI = 2.93, 14.71). Conversely, crash sites were less likely than control sites to have curvatures of less than 5° (OR = .42; 95% CI = .24, .73).

The sensitivity and specificity of several minimum curvature criteria for identifying crash sites varied inversely (Table 2). None of the criteria evaluated was highly sensitive, but it was possible to identify approximately 50 percent of crash sites with a specificity of 75 percent or greater.

There were four multiple-crash sites, each of which had two fatal motor vehicle immersions during the study period. Three of these sites had curvatures of greater than 30° (34°, 66°, 84°) over 1000 feet. The fourth had a curvature of 4° (less than its control) and no other explanatory features.

At two of 34 crash sites for which complete police reports were available, guard rails existed between the road and water at the time the crash occurred. Guard rails had been added to

TABLE 1—Incidence and Severity of Head and Other Injuries in 77 Motor Vehicle Immersion Deaths, Sacramento County, California 1974–85

Overall Injury Severity		Head Injury Severity	
Injury Severity Score	N (%) of Cases	Head Injury AIS*	N (%) of Cases
0	16 (21)	0	26 (34)
1	28 (36)	1	26 (34)
2–9	4 (5)	2	9 (12)
10–19	19 (25)	3	9 (12)
20+	10 (13)	4	7 (9)
Total	77	Total	77

*Includes external injuries to the head and face.

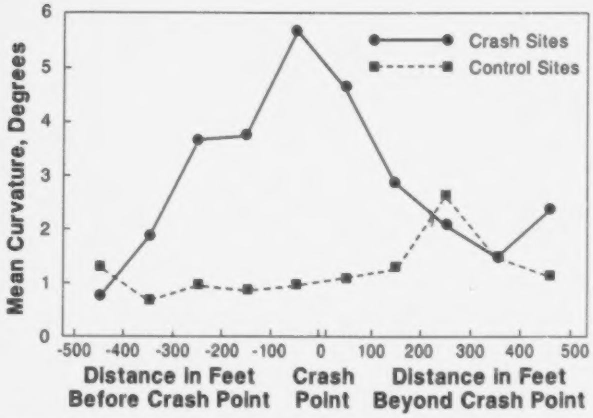

FIGURE 1—Mean Road Curvature over 1,000 Feet at 52 Fatal Motor Vehicle Immersion Sites and Matched Controls, Sacramento County, California 1974–85

five other sites, and extended at one of the first two locations, by the time our field investigation was conducted.

Discussion

These deaths represent an unusual subset of motor vehicle-related deaths, in that traumatic injury was generally minor if present at all. Death, generally by drowning, appeared to result more directly from the hostile environment in which the crash occurred. This may be particularly true for those cases involving minor head injury; transient disorientation or loss of consciousness may well result in death given that immersion has occurred. From the pathophysiologic viewpoint, these deaths are more properly considered drownings. From the prevention standpoint, their current classification as motor vehicle deaths seems appropriate.

The mortality rate for Hispanics was approximately five times that for other groups. These rates were calculated based on place of occurrence, but the observed difference did not result from a high proportion of out-of-county residents among Hispanic fatalities. A number of other factors may be involved. First, fatal immersions involving Hispanic vehicle occupants were more likely than others to result in multiple deaths. Second, the high risk roadways are in agricultural areas of the county. Since Hispanics in the Sacramento area are heavily involved in agriculture, their higher fatal immersion rate may result from a higher exposure to these roadways than that of other groups. Differences in alcohol use and driving experience may also play a role. A controlled study will be necessary to evaluate these possibilities.

TABLE 2—Sensitivity and Specificity of Various Minimum Curvature Criteria for Identifying Sites of 52 Fatal Motor Vehicle Immersions Occurring in Sacramento County, California 1974–85

Minimum Curvature over 1,000 feet (degrees)	Sensitivity (95% CI)	Specificity (95% CI)
10	.58 (.43, .71)	.58 (.43, .71)
15	.50 (.36, .64)	.75 (.61, .86)
20	.46 (.32, .61)	.88 (.76, .96)
30	.37 (.24, .51)	.94 (.84, .99)

Alcohol was a major contributing factor. Seventy-four percent of drivers meeting our sampling criteria had a positive BAC, as did 69 percent of drivers killed in single vehicle crashes nationwide in 1985.[8] Alcohol use was associated with increased injury severity. It is likely that alcohol use contributes to these deaths in two ways: by increasing the likelihood that an immersion event will occur, and by impairing the ability to escape a sinking vehicle.

Finally, we have demonstrated that roadway curvature is an important environmental contributing factor for fatal motor vehicle immersions. Similar results have previously been described for fatal crashes involving roadside fixed objects[5] and single vehicle fatal rollover crashes.[9,10] Sites at high risk for future crash involvement can therefore be identified for environmental modification.

Placing guard rails along waterside roadways would substantially decrease the incidence of immersions. The guardrail now in use in the study area is a w-beam, blocked-out design. Field studies have demonstrated that this design is highly efficient at redirecting impacting vehicles, with a penetration rate of less than 15 percent.[11] The cost of installing this guard rail averaged $14.50 per linear foot in 1988,* or $76,560 to protect one side of a mile of roadway.

It is probably not cost-effective to install guard rails throughout an entire system of waterside roadways. Using a curvature criterion would permit resources to be focused on the most hazardous locations. Nearly half of high-risk locations would be protected by installing guard rails along sections of roadway with curves of 20° or greater over 1000 feet, while minimizing installation in low-risk areas.

ACKNOWLEDGMENTS

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Drownings in Minnesota, 1980–85: A Population-Based Study

KATRINA HEDBERG, MD, PAUL D. GUNDERSON, PHD, CAROL VARGAS, MICHAEL T. OSTERHOLM, PHD, MPH,
AND KRISTINE L. MACDONALD, MD

Abstract: We conducted a population-based study of drownings in Minnesota from 1980 through 1985. Five hundred and forty-one drownings (2.1 per 100,000 person-years) were identified from death certificates and from incident reports filed with the Minnesota Department of Natural Resources. Most drownings (334, 62 percent) occurred during summer months (May–August) and involved boating (42 percent) and swimming (35 percent) events. However, 62 drownings (11 percent) occurred during winter months (December–February) and primarily involved snowmobiles and motor vehicles (71 percent) breaking through ice on lakes and waterways. The risk of drowning, estimated by the ratio of drownings to number of water-related activities, was highest during March and April, when the ice on lakes and waterway surfaces is melting, and during October and November, when lake and waterway surfaces are starting to freeze. Drowning rates were highest for males (3.7 per 100,000 person-years), persons 15 to 25 years of age (3.3 per 100,000 person-years), and children less than 5 years of age (2.5 per 100,000 person-years). These data can be used to target prevention strategies, particularly in northern climates. (*Am J Public Health* 1990; 80:1071–1074.)

Introduction

Drowning is the third most common cause of fatal, unintentional injury in the United States; among children and young adults it is the second most common cause.[1] In 1984, drowning accounted for 4,444 deaths nationwide.* Yet detailed epidemiologic data are lacking for outdoor and recreational drownings in northern climates, where surface water is frozen for several months of the year.[2]

Minnesota is known as "The Land of 10,000 Lakes." Water covers 7,353 square miles or 9.2 percent of the state's surface area. Lakes and waterways provide the 4.2 million people who live in Minnesota with numerous recreational opportunities throughout the year, including swimming and boating in the summer and ice-fishing in the winter. The lakes and waterways are usually frozen from December through March.

We conducted a population-based study of drownings in Minnesota, with an emphasis on outdoor and recreational drownings. In addition to characterizing drowning victims, we examined data by season-specific activities associated with drowning.

Methods

A case of drowning was defined as an unintentional death due to submersion in water, that occurred to a Minnesota resident during 1980 through 1985. Deaths involving motor vehicles operated in or on a body of water were considered to be drownings. However, deaths involving motor vehicles that ran off the road into water were considered to be motor vehicle fatalities.

Data on drownings were obtained from two sources: death certificates maintained by the Minnesota Center for Health Statistics, and fatal injury reports filed with the Minnesota Department of Natural Resources. All death certificates in Minnesota are assigned an ICD-9 cause of death code by a certified nosologist. Death certificates assigned an ICD-9 code for drowning were reviewed. This included both boating (E830-E832) and non-boating fatalities (E910).

Law enforcement officials are required to investigate and file a report with the Department of Natural Resources on all fatal injuries that occur on Minnesota lakes and waterways (Minnesota Statute 361.24). These officials often use coroner reports in preparing their reports. These reports were reviewed, and information was obtained on the age and sex of the victim; the date, time, and location of the incident; the victim's activity at the time of drowning; the probable cause of the drowning; and history of alcohol use. Death certificates and Department of Natural Resources reports were manually matched by name, age, and address.

Drowning rates were calculated for the general population of Minnesota residents using population data extrapolated from the 1980 census. To estimate rates of outdoor and recreational drownings for the specific population-at-risk, we calculated the ratio of drownings to the estimated number of water-related activities. The annual number of water-related activities in which Minnesota residents participated was extrapolated from a random telephone survey of 6,000 households conducted by the Department of Natural Resources during a 12-month period, beginning in September 1985.** Each week, a sample of households was contacted and asked to report the age and sex of household members and the number of water-related activities in which each member had participated during the preceding week. (Information was collected on a number of activities, but not on hours of activity.) In addition, we reviewed records that the Department of Natural Resources has maintained since 1944 on the number of drowning deaths that have occurred in Minnesota.

Data were analyzed using standard univariate methods.[3] Years of potential life lost prior to age 65 were calculated.[4]

Address reprint requests to Kristine L. MacDonald, Acute Disease Epidemiology Section, Minnesota Department of Health, 717 Delaware Street, SE, Minneapolis, MN 55440. Dr. Osterholm is also with the Acute Disease Epidemiology Section; Dr. Hedberg is with the Division of Field Services, CDC, Atlanta, GA, assigned to the Acute Disease Epidemiology Section, Minnesota Department of Health; Dr. Gunderson and Ms. Vargas are with the Center for Health Statistics, Minnesota Department of Health. This paper, submitted to the Journal September 19, 1989, was revised and accepted for publication February 8, 1990.

Editor's Note: See also related article p 1068 this issue.

*Division of Vital Statistics, National Center for Health Statistics (NCHS), Hyattsville, MD, (unpublished data).

**Minnesota Center for Survey Research, University of Minnesota. A continuous survey of participation and expenditures in outdoor recreation by Minnesota residents—Year end summary report, February 1987, (unpublished document).

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Results

Five hundred and forty-one drownings occurred to Minnesota residents during 1980 through 1985; 458 drownings (85 percent) were identified from death certificate review (ICD-9 codes E830-32 and E910) and 83 drownings (15 percent) were identified only from Department of Natural Resources reports (death certificates were retrieved for these drownings). These 83 deaths were coded as follows: 35 (42 percent) were assigned the ICD-9 code for drownings which reflects accidental or purposely inflicted cause undetermined (E984); 32 (39 percent) were assigned the code for motor vehicle fatalities (E820-25); and 16 (19 percent) were assigned other ICD-9 codes including cardiac arrests, diving accidents, falls and hypothermia.

Four hundred and ninety-one drownings (91 percent) occurred in Minnesota and 50 (9 percent) occurred out-of-state. Forty-three (86 percent) of the out-of-state drownings occurred in the states immediately adjacent to Minnesota or in areas with northern climates (Montana, Alaska, and Canada). The seasonal distribution for the out-of-state drownings was similar to the distribution of drownings which occurred in Minnesota. Five hundred drownings (92 percent) occurred outdoors or were related to recreation and 41 drownings (8 percent) occurred in bathtubs. Department of Natural Resources reports were completed on 404 (90 percent) of the 450 outdoor and recreational drownings that occurred in Minnesota.

Death Certificate Review

The 541 drownings identified represent an overall mean annual incidence of 2.1 drownings per 100,000 person-years. The annual incidence declined over the study period from 2.5 per 100,000 person-years in 1980 to 1.9 per 100,000 person-years in 1985. This finding is consistent with a decreasing trend in the annual incidence of drowning observed in Minnesota since 1944. The drownings that occurred during the study period represent 17,853 years of potential life lost before age 65 (33 years lost for each death).

The majority of drownings (334, 62 percent) occurred during the summer months, May through August, when outdoor and recreational activities peak (Figure 1). However, 62 drownings (11 percent) occurred during the winter months, December through February, when lakes and waterways are frozen, and water-related activities are low. The risk of drowning, estimated by the ratio of drownings to number of water-related activities, was highest during spring and fall months (Figure 1).

Overall, 447 drownings (83 percent) occurred in males (Figure 2). The mean annual incidence for males was 5.3 times higher than that for females (3.7 versus 0.7 per 100,000 person-years, respectively). Incidence rates were highest for persons 15 to 30 years of age and for person less than 5 years of age (3.3 and 2.5 per 100,000 person-years, respectively). For the age group 15 to 30 years, 91 percent of drownings occurred in males. For this age group, the rate for males was 10 times higher than the rate for females (5.2 versus 0.5 per 100,000 person-years, respectively). The ratio of number of drownings to number of water-related activities for males was 3.3 times higher than the ratio for females (13.7 versus 4.2 per 1,000,000 activities, respectively).

The drowning rate for persons 15 to 49 years of age decreased significantly over the six-year study period ($p < 0.001$, chi-square test for trend). However, rates for persons less than 15 years of age and for persons greater than or equal to 50 years of age did not show a similar decrease ($p = 0.22$, and 0.82, respectively, chi-square test for trend).

Department of Natural Resources (DNR) Incident Report Review

DNR report forms were completed for 404 of the outdoor and recreational events. Of these, 382 (95 percent) occurred in a lake, pond, river, or stream, and 18 (4 percent) occurred in a swimming pool.

Table 1 shows the type of activity in which victims were engaged at the time of drowning. Swimming and boating were the most common activities during the summer, driving a vehicle on ice was the most common activity during the winter, while boating and falling from a bank into a body of water were common activities during the fall and spring.

Type of activity also varied by age group. For all ages combined, 66 drownings (16 percent) were due to falling from land, pool-side, or through ice into a body of water. However, for the 29 drownings that occurred in children <5 years of age, 22 (76 percent) were due to falling into a natural body of water or through ice, and three (10 percent) were due to falling into swimming pools. For the 21 drownings that occurred in persons ≥60 years of age, all were due to falling into water from land, pool-side, or through ice.

One hundred and thirty-five of the 404 drownings (33 percent) involved boating incidents. Table 2 shows the probable cause of boating-related drownings and the use of a

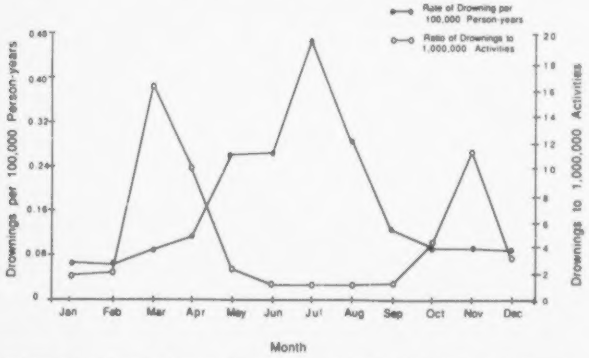

FIGURE 1—Mean Incidence of Drowning by Month, Minnesota, 1980 through 1985

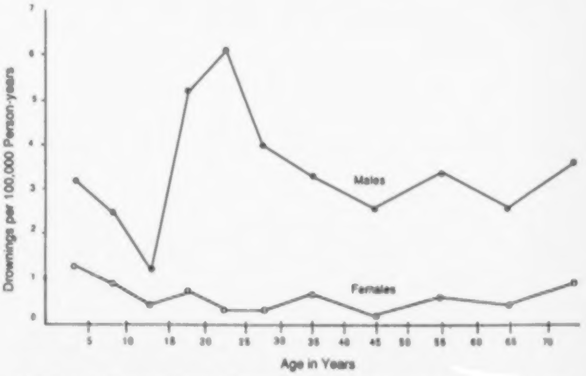

FIGURE 2—Mean Incidence of Drowning by Gender and Age Group, Minnesota, 1980 through 1985

TABLE 1—Type of Activity Reported at the Time of Drowning by Season, Minnesota, 1980 through 1985

Activity	Summer (May–Sept) No. (%)	Fall (Oct–Nov) No. (%)	Winter (Dec–Feb) No. (%)	Spring (Mar–Apr) No. (%)
Swimming/Wading	120 (42)	—	1 (2)	3 (8)
Boating	100 (35)	23 (60)	1 (2)	11 (28)
Fall from bank	30 (10)	7 (18)	—	11 (28)
Inner-tubing	10 (3)	—	—	—
Diving	7 (2)	—	—	—
Vehicle on ice	—	4 (11)	29 (71)	7 (18)
Walking on ice	—	4 (11)	10 (25)	4 (10)
Rescue attempt	2 (1)	—	—	—
Other	2 (1)	—	—	3 (8)
Unknown	15 (5)	—	—	—
Total (N = 404)	286 (100)	38 (100)	41 (100)	39 (100)

TABLE 2—Boating-Related Drownings by Cause and Use of Personal Flotation Device, Minnesota, 1980 through 1985

Cause	No.	(%)
Capsize/Sink	66	(49)
Fall Overboard	38	(28)
Collision—Boat/Dock	16	(12)
Other/Unknown	15	(11)
Total	135	(100)
Use of PFD*		
Used	13	(10)
Available/Not Used	66	(49)
Not available	54	(40)
Unknown	2	(1)
Total	135	(100)

*Personal flotation device

personal flotation device. Only 13 drownings (10 percent) occurred while such a device was being used.

History of alcohol use was noted on 242 reports (60 percent); three (6 percent) of 54 persons less than 15 years of age and 109 (58 percent) of 188 persons more than 15 years of age were reported as having consumed alcohol at the time of the event.

Discussion

The mean annual incidence of drowning in Minnesota during 1980 through 1985 (2.1 per 100,000 person-years) was lower than the 1984 incidence of drowning nationally (2.3 per 100,000 person-years),[5] and lower than the incidence in Georgia from 1981 through 1983 (3.2 per 100,000 person-years),[6] New Mexico from 1975 through 1980 (4.3 per 100,000 person-years),[7] North Carolina from 1980 through 1984 (3.2 per 100,000 person-years),[8] and Los Angeles County from 1976 through 1984 (2.4 per 100,000 person-years).[9] This probably reflects the fact that the peak season when people are participating in outdoor water activities is shorter in Minnesota where lakes and waterways are usually frozen for several months of the year.

We believe that a population-based incidence rate provides an accurate estimate of the risk of drowning and can be compared to population-based rates in other states. Yet, population-based rates assume that every resident in the state is at equal risk of drowning. The ratio of drownings to the number of water-related activities provides an estimate of the risk of drowning for the specific population that participates in water-related activities. The importance of this estimate is illustrated by the seasonal trends in drowning rates.

Previous investigators have noted that the incidence of drowning has marked seasonal variation.[1,10] In Minnesota, as in other states, most drownings occurred during the summer. However, if the risk of drowning is estimated by the ratio of drownings to number of water-related activities, the risk was highest during the spring and fall months, when the ice on the lakes is starting to freeze or thaw and likely to be unsafe. In addition, a submersion incident may be more likely to result in a fatality during the non-summer months due to the increased risk of hypothermia. Thus, this increased risk is probably specific to areas where surface water freezes during the winter.

Investigators in Hawaii and California found that the majority of drownings in these areas occurred in swimming pools.[9,11,12] However, we found that 95 percent of drownings in Minnesota occurred in lakes and waterways and only 4 percent occurred in swimming pools. Even in children less than 5 years of age, only three drownings occurred as a result of falling into swimming pools. Minnesota residents may use swimming pools less than residents of more southern climates because most people have access to natural bodies of water and because of the relatively short season in which people can swim outdoors. Therefore, prevention measures such as requiring all swimming pools to be fenced in, which have proved to be effective in other areas,[13] may have only limited impact in areas similar to Minnesota.

Our data showed that males, children, and young adults had the highest rates of drowning, a finding consistent with several past studies.[6-12,14-16] Comparing population-based rates, the incidence in males was 5.3 times the incidence in females. However, if the risk of drowning is estimated by the ratio of drownings to the number of water-related activities, the risk for males was only 3.3 times the risk for females. Thus, some of the excess risk seen in males may be due to increased time spent participating in water-related activities.

Behavioral factors which may put people at increased risk of drowning include alcohol consumption[16-19] and the nonuse of a personal flotation device. Although more than half of the Minnesota Department of Natural Resources reports completed for persons over 15 years of age listed alcohol consumption as contributing to the drowning, we do not know the number of people consuming alcohol that did not drown. Also, although only 10 percent of boat-related drownings occurred while a flotation device was being used, we do not know how many people who were wearing such devices did not drown, or how many drownings were avoided by people wearing such devices. Therefore, although our data suggest that alcohol consumption and the nonuse of a flotation device may increase the risk of drowning, we are unable to evaluate the exact contribution of these possible risk factors.

Although the overall rate of drowning in Minnesota decreased during the study period, only the rate in persons 15 to 49 years of age showed a significant decline. Risk-taking behavior may have contributed more to drownings in this age group than in other age groups, and may have been more amenable to current intervention strategies. The decrease in the incidence of drowning deaths may also have been a result of improved medical treatment. However, we were unable to evaluate this due to the lack of data on near-drownings.

To design, implement and evaluate injury intervention strategies, accurate surveillance data on injuries are needed.

Previous investigators have questioned the accuracy and usefulness of death certificates for obtaining selected mortality statistics.[20] In our study, 15 percent of the drownings were identified from the Department of Natural Resources reports and would have been missed if we had relied solely on death certificate review. We did not include death certificates assigned ICD-9 code E-984 in our initial review because we wanted to exclude suicides and homicides from the study. However, by examining information from the Department of Natural Resources reports, we were able to include those deaths which were unintentional. In addition, one-third of the drownings identified from the Department of Natural Resources reports had been assigned an ICD-9 code for a motor vehicle fatality. We chose to include only those deaths in which the vehicle was operated on an ice-covered body of water and exclude those in which the vehicle had run off a road into water, assuming that different risk factors may have been involved. Such information on the circumstances surrounding the events was available from the Department of Natural Resources reports but was lacking on most death certificates. This information is vital to understanding the causes of drowning and can be used to target further prevention strategies.

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Society for Disability Studies Issues Call for Papers

The Society for Disability Studies has issued a call for papers for its fourth annual convention, to be held June 19–22, 1991, in San Francisco, California. Possible themes for paper presentations may include research issues of policy, history, sexuality, law, culture, statistics, methods, politics, media, literature, gender, self-image, cross-cultural, family, and related topics. Organized panels are encouraged, but they must be multidisciplinary and cross disability. Proposals for roundtables are also encouraged, and they should attempt to bring together participants with similar research interests.

The deadline for submission of abstracts is January 15, 1991. Please send two copies of a two-to-three page abstract to: Professor David Pfeiffer, Department of Public Management, School of Management, Suffolk University, Boston, MA 02108. Tel: (617) 573-8317.

The Society for Disability Studies is a multidisciplinary organization dedicated to the development of an appreciation and understanding of disability-related theory and its application as well as an agenda for further research in this area. For information about the Society, or its periodical, *Disability Studies Quarterly*, contact Professor Irving Kenneth Zola, Department of Sociology, Brandeis University, Waltham, MA 02254-9110. Tel: (617) 736-2644.

A Multifocal Outbreak of Hepatitis A Traced to Commercially Distributed Lettuce

LISA S. ROSENBLUM, MD, MPH, IRENE R. MIRKIN, MD, DAVID T. ALLEN, MD, SUSAN SAFFORD, MD,
AND STEPHEN C. HADLER, MD

Abstract: From February 1 through March 20, 1988, 202 cases of hepatitis A were reported in and around Jefferson County, Kentucky. The epidemic curve indicated a common-source exposure. However, there was no apparent single source of exposure from a restaurant, or community gathering; nor was there a geographic clustering by residence. Cases were mainly adults 20–59 years old (89 percent); 51 percent were female. A case-control study using neighborhood controls found that factors associated with hepatitis A were: having eaten downtown (odds ratio [OR] = 4.0) and having dined at any one of three restaurants (OR = 21.0). Case-control studies of patrons of two of these restaurants found that eating green salad was strongly associated with acquiring hepatitis A: OR = 11.6 and OR = 4.4. The three implicated restaurants accounted for 71 percent of the cases. All three restaurants were supplied by the same fresh produce distributor; however, investigation suggested that contamination most likely occurred prior to local distribution. This outbreak of hepatitis A is the first in the United States apparently associated with fresh produce contaminated before distribution to restaurants, and raises important public health issues regarding the regulation of fresh produce. (*Am J Public Health* 1990; 80.1075–1080.)

Introduction

In 1988, 26,600 cases of hepatitis A were reported in the United States.[1] During 1983–88 the incidence of reported cases of hepatitis A increased from 9.2 to 10.9 per 100,000 population, representing the first increase in hepatitis A in more than a decade.[1-3] An estimated 1,000 cases are associated with suspected food- or water-borne outbreaks of hepatitis A each year.[3]

Previous investigations of common-source food-borne outbreaks of hepatitis A have described unifocal outbreaks in which a single location of food consumption (such as a restaurant) was the site of the outbreak; generally, a food handler, recently infected with hepatitis A virus (HAV) and working at that site, was implicated as the source of contamination of the food.[4-6] There have also been reports of outbreaks involving more than one restaurant; however, a food handler was implicated as the source of contamination at each restaurant.[4,7] The major multifocal food-borne outbreaks of hepatitis A due to the contamination of food before distribution to a restaurant have involved shellfish harvested from contaminated bays.[8,9] Reports from the United Kingdom have suggested that certain commercially processed foods (such as frozen raspberries) may have been associated with the transmission of HAV.[10,11]

This is the first report of a hepatitis A outbreak in the United States associated with unprocessed fresh produce contaminated before distribution to restaurants.

Methods

From February 1 through March 20, 1988, a widespread outbreak of hepatitis A affected 202 residents of Jefferson County, Kentucky (1986 intercensal population estimate, 681,066) and the surrounding area. The Louisville-Jefferson County Board of Health, the Kentucky Department of Health, and the Centers for Disease Control initiated a series of investigations to determine the risk factors for the transmission of HAV.

Case Identification

A case was defined as a person who had onset of an illness compatible with viral hepatitis from February 1 through March 20, 1988, and either a positive serologic test for immunoglobulin M (IgM) antibody to HAV (IgM anti-HAV) or a physician diagnosis of hepatitis A. Cases were ascertained through reports by physicians to the Louisville City-Jefferson County Health Department. Serologic testing for IgM anti-HAV was performed by private and hospital-based laboratories in Louisville. All cases were interviewed by telephone to obtain demographic information, date of onset and clinical course of illness, work location, and place of residence.

Community Food and Water Exposure Study

Because the epidemic curve indicated a common source of exposure, a case-control study using neighborhood controls was performed to identify the location of the common source of food or water in the community. A random sample of cases who resided in Jefferson County were matched with controls by neighborhood and by age within 10 years. One control who lived within 10 houses in either direction from each case was selected randomly by using a reverse telephone directory. Eligible controls had no history of hepatitis; no undiagnosed illness during February or March, with any two of the following symptoms: jaundice, nausea, vomiting, and abdominal discomfort; no receipt of immune globulins within the past six months; and no household or sexual contact with a person with hepatitis A since January 15, 1988. Cases and controls were interviewed by telephone to obtain demographic information, history of food and water exposures at home and work, and exposures at restaurants, stores, parties, and community gatherings during January 15–31.

Restaurant Food Exposure Studies

Because the neighborhood study found that eating at any one of three restaurants was associated with acquiring hepatitis A, two of the restaurants (A and B) were selected as sites for the investigation of the source of HAV. Restaurants

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Address reprint requests to Lisa S. Rosenblum, MD, Medical Epidemiologist, Hepatitis Branch, Division of Viral Diseases, Center for Infectious Diseases, Centers for Disease Control, Atlanta, GA 30333. Dr. Hadler is also with that Branch; Dr. Mirkin is with the Division of Field Services, Epidemiology Program Office, CDC; Dr. Allen is with the Louisville-Jefferson County Board of Health, Louisville, KY; Dr. Safford is with the Epidemiology Program Office, CDC. This paper, submitted to the Journal November 27, 1989, was revised and accepted for publication March 28, 1990.

A and B were selected because they accounted for most of the cases, and no case had patronized both restaurants. Restaurant A, located in a downtown professional district, was primarily a lunch business, serving sandwiches, chef salads, and soup. Restaurant B, located in the outskirts of the city, was primarily a dinner restaurant, with standard American fare and a salad bar.

The period of risk of exposure at these restaurants was considered to be January 15–31, one month (the average incubation period for HAV) preceding the period of peak case incidence (February 15–28). Evaluation of the dates of exposure of patrons who ate only once at one of these restaurants (A or B) and ate at no other restaurants in Jefferson County during the month preceding their illness confirmed that January 15–23 was the period of high risk.

For each restaurant study, eligible cases and controls had dined at the designated restaurant (A or B) during January 15–31; controls also had to meet the four eligibility criteria described for controls in the neighborhood study. For the study of restaurant A patrons, unmatched controls were randomly selected from a list of coworkers of each case. For restaurant B, controls were meal companions of the cases. Telephone interviews of cases and controls obtained demographic information and history of food consumption, including the frequency of eating particular foods.

Investigating the Source of Contamination

Based on the results of the restaurant studies, which implicated fresh produce obtained from a single local distributor, the Food and Drug Administration traced the source of shipments of food received by the distributor. In collaboration with the Louisville-Jefferson County Board of Health, the Louisville Water Company evaluated the water supply system.

Statistical Methods

In the community case-control study, exact confidence limits for the odds ratios were calculated by using standard procedures for the binomial distribution.[12] MCSTRAT (a procedure in Statistical Analysis Systems), which is designed for matched case-control data, was used to estimate the variances of the odds ratios in multivariate analysis.[13] For the restaurant case-control studies, variances for the odds ratios were estimated by using the method described by Cornfield.[12]

Results

Outbreak

From February 1 through March 20, 1988, 202 reported cases of hepatitis A met the case definition; 99 percent were tested and confirmed as IgM anti-HAV positive. Cases included 172 Jefferson County residents, and 30 others who had histories of exposures in Jefferson County during the last two weeks in January.

During the 13 months preceding the epidemic, only 12 cases of hepatitis A had been reported in Jefferson County. During the epidemic, there was no increase in the number of cases reported in any of the surrounding counties in Kentucky or Indiana, except for the cases who had known exposures in Jefferson County.

The epidemic curve, with a sharp peak and most of the cases occurring within the two-week period, suggested a common-source exposure (Figure 1). There was no apparent single source of exposure from a restaurant or community gathering and no geographic cluster by location of residence; only seven families had more than one case. Cases clustered by work location, with 33 percent of the cases working in the downtown area.

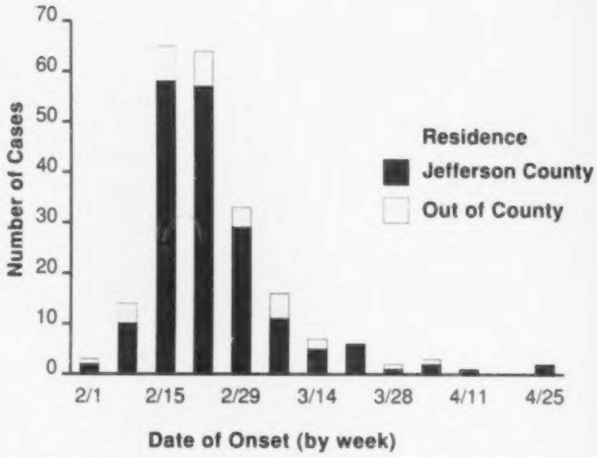

FIGURE 1—Hepatitis A Cases by Date of Onset of Symptoms, Jefferson County, Kentucky, February 1–April 30, 1988

Of the cases residing in Jefferson County, the mean age was 38 years (range: 1 to 75 years), 89 percent were 20 to 59 years old, and 51 percent were female. The overall attack rate was 25 cases per 100,000 residents of Jefferson County. The highest attack rate was for adults 20 to 59 years old (40 cases per 100,000 persons), with the highest age-specific attack rate occurring among persons 40 to 49 years old (62 cases per 100,000). Of the 172 cases, 91 percent were jaundiced and 23 percent were hospitalized. HAV infection may have contributed to two deaths (for a case-fatality ratio of 1 percent), including a 60-year-old man who required a liver transplant five months after the onset of illness and died two months later, and a 53-year-old man with a history of alcohol abuse, who died three weeks after onset of illness.

Community Food and Water Exposures

In the study of community food and water exposures, 30 neighborhood case-control pairs were interviewed. A comparison of cases and their matched controls indicated that 70 percent of the pairs had similar levels of income and education, and all were White and non-Hispanic.

Exposures associated with acquiring hepatitis A in univariate analysis included (Table 1) working downtown (odds ratio [OR] = 5.0), having eaten downtown (OR = 4.0), having dined at any one of three (A, B, or C) restaurants (OR = 21.0), and having eaten salad at any restaurant (OR = 6.0). Two of the three implicated retaurants were located downtown. The association between acquiring hepatitis A and having dined at these three restaurants persisted when results were adjusted separately for history of work downtown, and for potential confounders (e.g., income and education).

Restaurant Food Exposures

Restaurant A: In the study of patrons of restaurant A, 38 (100 percent) of the eligible cases were interviewed, and 36 fellow office workers were interviewed as controls. The study found that eating green salad was associated with an 11.6-fold increased risk of acquiring hepatitis A (Table 2). Consumption of other foods was not associated with an increased risk of disease. The risk of acquiring hepatitis A increased as the frequency of consumption of green salads increased from a

TABLE 1—Neighborhood Study of Community Food and Water Exposures

Exposure	% Cases exposed (n = 30)	% Controls exposed (n = 30)	Matched odds ratio	95% confidence interval
Patronize restaurants				
A, B, or C	77	10	21.0	3.4, 832.3
A	30	0	∞	2.0, ∞
B	33	7	9.0	1.2, 399.0
C	23	3	∞	1.1, ∞
Work downtown	40	13	5.0	1.1, 46.6
Eat downtown	47	17	4.0	1.1, 21.7
Eat salad at any restaurant	83	50	6.0	1.3, 49.0
On public water supply	100	97	∞	—
Patronize grocery store 1	70	73	0.8	0.1, 4.2
Patronize grocery store 2	30	23	1.4	0.4, 5.3
Drink water at workplace	77	70	1.5	0.4, 7.2
Use ice machine at work	37	23	1.7	0.6, 5.6

TABLE 2—Restaurant A: Study of Food Exposures

Food Consumed	(%) Cases exposed	(%) Controls exposed	Odds ratio	95% confidence interval
Green salads	32/38 (84)	11/35 (31)	11.6	3.4, 42.8
Soup	26/38 (68)	20/36 (56)	1.7	0.6, 5.0
Prepared salads	16/38 (42)	13/36 (36)	1.3	0.5, 3.7
Iced drinks	9/38 (24)	11/36 (31)	0.7	0.2, 2.2
Sandwich	22/38 (58)	32/36 (89)	0.2	0.04, 0.7
Dressing (if ate salad)	26/32 (81)	11/11 (100)	0.0	0.0, 2.7
Garnish on sandwich (among nonsalad eaters)	6/6 (100)	13/24 (54)	∞	0.8, ∞
Green salads, or garnish on sandwich	38/38 (100)	24/36 (67)	∞	0.0, ∞

1.0-fold risk for those never ordering salad, to an 8.0-fold risk for those sometimes ordering salad, to an 18.0-fold risk for those always ordering salad ($p < .001$, Mantel-Haenszel trend test).

Among those not eating salad, there was an association between disease and consumption of a sandwich with a lettuce or a tomato garnish ($p = .046$). All cases ordered either a green salad or a sandwich with a garnish. The high correlation between ordering a lettuce and a tomato garnish on a sandwich (.74) precluded analysis of the risk of disease associated with a single vegetable.

Restaurant B: In the study of patrons of restaurant B, 48 (100 percent) of the eligible cases and 43 controls were interviewed. Results indicated that eating salad from the salad bar was associated with a 4.4-fold risk of infection and that ordering either the salad bar or a tossed salad with a main dish was associated with a 6.7-fold risk of disease (Table 3). No other menu item was associated with increased risk.

Patrons of restaurant B were interviewed about the consumption of specific food items from the salad bar; however, no single item could be implicated. The high degree of correlation between ordering two given items from the salad bar precluded further analysis of the risk associated with a single salad bar item. Among those eating salad, salad dressing was not associated with increased risk of infection.

Tracing the Source of Contaminated Fresh Produce

During January 15–30, 71 percent of the cases reported exposures at any one of the three implicated restaurants. The peak of the epidemic curve associated with each of these restaurants occurred the same week. Three of the reported cases were food handlers at restaurant A, and one was a food handler at restaurant B; however, the dates of onset of illness among these employees were within the main part of the epidemic curve, not consistent with transmission to their customers, and the employees did not work at other restau-

TABLE 3—Restaurant B: Study of Food Exposures

Food consumed	Cases exposed* n (%)	Controls exposed* n (%)	Odds ratio	95% confidence interval
Salad bar	40/48 (83)	23/43 (53)	4.4	1.5, 12.8
Salad bar or tossed salad	43/46 (93)	28/41 (68)	6.7	1.6, 32.6
Fish	4/45 (9)	3/40 (8)	1.2	0.2, 7.4
Seafood	3/44 (7)	4/41 (9)	0.7	0.1, 3.9
Meat	25/44 (57)	25/37 (68)	0.6	0.2, 1.7

*If a respondent did not answer a question, the respondent was excluded from analysis for that exposure.

rants. The remainder of the employees at restaurant A were tested and were negative for IgM anti-HAV.

The epidemiologic studies implicated salad as the vehicle of transmission, and results of the study at restaurant A suggested that either lettuce or tomatoes were the contaminated produce. Lettuce was considered the most probable vehicle of transmission because all the implicated types of salads contained lettuce, and because lettuce, as compared with other produce such as tomatoes, is harder to clean thoroughly by rinsing. Since all three of the implicated restaurants served iceberg lettuce, and two of the three restaurants served only iceberg lettuce, the suspected vehicle was iceberg lettuce.

All three restaurants were supplied by the same local fresh produce distributor. (Less than 5 percent of food service establishments in Jefferson County were supplied by the implicated distributor.) At the implicated distributor, no hepatitis A cases were identified among the workers, and the handling of produce was minimal. Produce was generally not unpacked from the crates in which it was shipped and not washed or processed. Therefore, contamination most likely occurred before local distribution.

Shipments of iceberg lettuce that would have been received by the local distributor in Louisville January 11–16 were traced to four domestic suppliers; however, no information was available regarding the farm source of lettuce provided by these suppliers. Just before the outbreak in January of 1988, the importation of Mexican iceberg lettuce increased 10-fold[14] because of drought in the Summer of 1987 in the United States (Figure 2). Mexican iceberg lettuce was observed in Louisville bv local United States Department of Agriculture (USDA) inspectors during the last two weeks in January (J. Sullivan, Louisville-Jefferson County Board of Health, personal communication, March 1988). However, there is no information available to determine if Mexican imported produce was received by the local distributor or its suppliers.

Investigation of the Water System

The results of bacteriologic sampling of the water distribution system were within normal limits during the months of January and February 1988. No relationship was found between the geographic distribution of cases and the water distribution system or events such as water company construction, repair, and unusual flow disturbances.

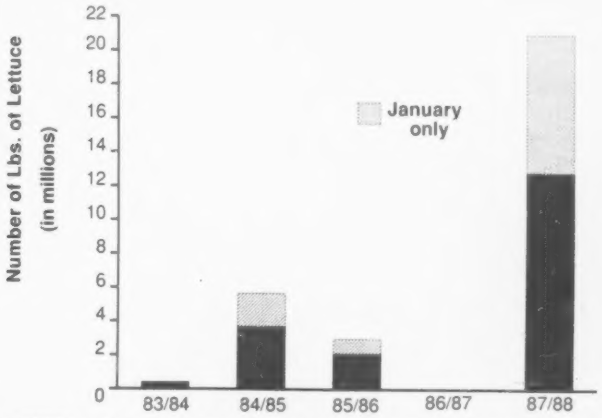

FIGURE 2—Iceberg Lettuce Imported from Mexico, Winter (November–February: 1983–88
SOURCE: Agricultural Marketing Service, US Department of Agriculture

Discussion

This common-source outbreak of hepatitis A was unusual in that there was no single source of exposure from a restaurant or community gathering, nor was there geographic clustering by neighborhood. The epidemic curve, with a sharp peak and most of the cases occurring within a two-week period, indicated a common source of exposure. The age distribution (88 percent of the cases in adults 20 to 59 years old) was atypical of community person-to-person spread and suggested that the persons primarily affected by the epidemic were a "working" cohort.

Case-control studies found that the outbreak was due to contaminated salad served by several restaurants. Because serum specimens of controls were not tested, it is possible that some controls may have been immune or asymptomatic cases. For this possibility to have accounted for the observed associations, there would have to have been an association between exposure, and either immunity or expression of illness However, without such an assumption (for which there is no basis), the presence of immune controls or asymptomatic cases would tend to produce a conservative estimate of the associations observed.

This is the first report of an outbreak of hepatitis A in the United States associated with a vegetable product which was contaminated prior to distribution to restaurants. At least three restaurants were involved in the outbreak, each accounting for no more than one-third of the cases. Foodhandlers at the restaurants were unlikely to have been the source of the epidemic for two reasons. First, no index case was identified at any of the restaurants. Although serosurveys were not performed at all restaurants, most (76–97 percent) of HAV infections among adults are symptomatic.[14] Second, because the epidemic curve was unimodal, it was unlikely that foodhandlers at each restaurant could have accounted for transmission of HAV to their clientele. Contamination of the produce most likely occurred before local distribution to the restaurants, as there was no hepatitis A case identified among the workers, and there was minimal handling of produce at the local distributor which supplied the three restaurants.

The most likely vehicle of transmission was iceberg lettuce; however, the exact farm source of contaminated lettuce could not be determined. There was no evidence of concurrent outbreaks in the United States associated with lettuce contaminated before local distribution, and the focal nature of the outbreak suggested that either a limited supply of lettuce grown in the United States or imported lettuce had been contaminated. During the peak period of importation in January 1988, Mexican lettuce accounted for only 1 percent of the total US consumption,[15] with any single grower accounting for a small fraction of the total. Contamination of the produce may have occurred in the fields from contaminated water used for growing or irrigation, or from the use of night soil (excrement removed from a cesspool or privy and used as fertilizer). Alternatively, contamination may have occurred during the shipping process if riders were transported in the back of the truck with the produce.

Lettuce contaminated before distribution to food-service facilities also has been associated with two recent large epidemics of shigellosis.[16,17] In these outbreaks, contamination was believed to have occurred in the field or a warehouse,[16] and in a food-processing plant.[17] Laboratory studies have demonstrated the survival of HAV (in feces) and *Shigella* (in a variety of nonacidic foods) for several weeks at 25 °C.[18,19] These outbreaks underscore the importance of proper sanitation facilities, and good hygiene of workers at each step of the food handling chain.

The timing of the marked increase in imported lettuce in relation to this outbreak, which was associated with fresh produce contaminated before local distribution, raises public health concerns regarding the regulation of imported fresh produce. The purity of water supply used in growing, availability of sanitation facilities to workers, and possible use of night soil by foreign lettuce growers, have not been determined. Imported lettuce is not routinely examined for evidence of fecal contamination at the port of entry to the United States. Imported unprocessed lettuce is exempt from US Customs requirements to label the country of origin on the imported article itself.[20] Although the country of origin must be marked on the outermost container of lettuce that reaches the ultimate purchaser,[20] containers such as supermarket bins and rubberbands holding fresh produce are not subject to marking; if produce should reach the ultimate purchaser without a container, there is no requirement to display the country of origin (M. Amernick, Esq., US Customs, personal communication, October 1989).

Moreover, because there are no federal requirements to label the name of the farm on either imported or domestic lettuce that reaches the ultimate purchaser, and because more than one farm can supply any supplier, it may be impossible to trace lettuce to the growing site during an outbreak, as was the case in this epidemic.

During 1983–88, for the first time in over a decade, there has been a nationwide increase in reported cases of hepatitis A[1-3]; the cause of the increase is not known. This multifocal epidemic of hepatitis A is the first report of an outbreak in the United States associated with a vegetable contaminated before distribution to restaurants, and raises important public health concerns regarding the regulation of both domestic and imported fresh produce.

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Impact of the Human Immunodeficiency Virus Epidemic on Mortality Trends in Young Men, United States

James W. Buehler, MD, Owen J. Devine, Ruth L. Berkelman, MD, and Frances M. Chevarley, PhD

Abstract: Following a long-term decline, death rates in men 25–44 years of age increased from 212 deaths/100,000 in 1983 to 236 deaths/100,000 in 1987. To assess the impact of human immunodeficiency virus (HIV) infections on this trend and to identify causes that are increasing in association with the HIV epidemic, we analyzed national mortality statistics and compared death rates in states with high and low incidence of acquired immunodeficiency syndrome (AIDS). In 1987, there were 10,248 deaths with HIV infection, AIDS, or conditions in the AIDS surveillance definition assigned as the underlying cause, representing 11 percent of deaths for men in this age group compared to less than 1 percent in 1980. In addition, deaths with other underlying causes, such as other infections, drug abuse, and unknown/unspecified causes, had diverging and higher rates in states with high versus low AIDS incidence. In the absence of deaths due to HIV/AIDS and excess deaths due to these associated conditions, we estimate that death rates for men 25–44 years of age would have been 201–209/100,000 in 1987. For 1987, approximately 70–90 percent of HIV-related deaths were reported through national AIDS surveillance. The HIV epidemic has led to a reversal in mortality trends and to increases in various causes of death for young men. (*Am J Public Health* 1990; 80:1080–1086.)

Introduction

Following a long-term decline, death rates in men 25–44 years of age have begun to increase in the 1980s in the United States (Figure 1). This reversal of mortality trends has coincided with the epidemic of human immunodeficiency virus (HIV) infections and acquired immunodeficiency syndrome (AIDS), which has predominantly affected young men.[1] Deaths due to HIV infection have emerged as a leading cause of years of potential life lost,[2,3] and provisional mortality data from the national vital statistics system indicated that HIV infection ranked fifteenth in 1988 among all causes of death in the United States.[4]

To measure the impact of the HIV epidemic on mortality in young men, we used national mortality data to identify causes of death that are increasing in association with the HIV epidemic and to estimate the number of HIV-related deaths. In these analyses, we examined death rates for a broad spectrum of causes. We focused not only on HIV infection and diseases in the surveillance definition for AIDS but also on other infections and malignancies which have had a suggested link to HIV. In addition, to assess the completeness of national AIDS surveillance, we compared our estimate of HIV-related deaths from vital statistics to mortality data from AIDS case reporting.

Methods

Death Rates 1980–1987

We calculated death rates (deaths/100,000 population) using computer tapes prepared by the National Center for Health Statistics (underlying and multiple causes of death) and the Bureau of the Census.[5,6] We limited our analyses to men, ages 25–44 years, who were United States residents (excluding territories). To identify causes of death associated with HIV infection, we compared mortality trends for four groups of states ranked by AIDS incidence rates, using data from national AIDS surveillance.[7] The highest group (California, Florida, New Jersey, New York, and the District of Columbia) accounts for 59 percent of all AIDS cases reported in men 25–44 years of age, while the lowest group (21 states) accounts for 5 percent of cases. We calculated crude, race-, and age-adjusted death rates. Adjusting for race did not affect the identification of causes that increased more rapidly in states with highest AIDS incidence, and adjusting for age had virtually no effect on comparisons by year or state group. Thus, we present only death rates unadjusted by race or age.

We grouped cause-of-death codes from the Ninth Revision of the International Classification of Disease (ICD-9)[8] into the following categories: HIV infection or AIDS (ICD-9 No. 279.1 for 1980–86, category *042–*044 for 1987*, see below); diseases included in the national surveillance case definition for AIDS (*Pneumocystis carinii* pneumonia, other AIDS-defining infections, Kaposi's sarcoma, non-Hodgkin's lymphomas, encephalopathy, wasting syndrome)[9,10]; other immune deficiency (excludes conditions assigned ICD-9 No. 279.1 in 1980–86, see below); infections not in the AIDS surveillance definition (pneumonia and influenza, septicemia, pulmonary tuberculosis, heart, central nervous system, all other infections); blood disorders (congenital coagulation defects, others); selected cancers with a postulated link to HIV infection (oral-pharyngeal, anal-rectal, other gastroin-

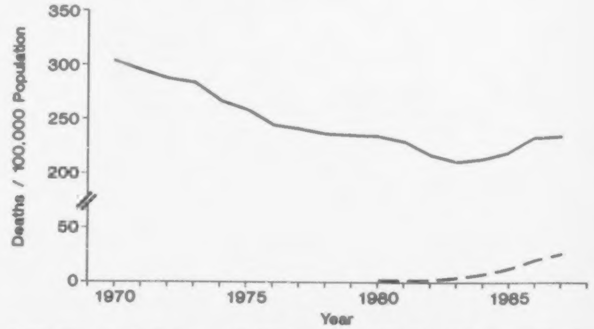

FIGURE 1—Death Rates per 100,000 Population 1970–87 (solid line), and Death Rates per 100,000 for HIV/AIDS and Conditions in AIDS Surveillance Definition, 1980–87 (broken line), Men 25–44 Years of Age, United States

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*The notation "category *042–*044" indicates that these are supplemental codes and not part of ICD-9.[9]

Address reprint requests to James W. Buehler, MD, Division of HIV/AIDS, Center for Infectious Diseases, Centers for Disease Control, USPHS, Atlanta, GA 30333. Co-authors Devine and Dr. Berkelman are also with that Division at CDC; Dr. Chevarley is with the Office of Vital and Health Statistics, National Center for Health Statistics, Hyattsville, MD. This paper, submitted to the Journal October 10, 1989, was revised and accepted for publication January 31, 1990.

testinal cancers, Hodgkin's lymphoma)[11–19]; lung cancer, other cancers; injuries (suicide, homicide, unintentional injuries); drug abuse; other system disorders exclusive of above causes (endocrine/metabolic, mental/nervous, cardiovascular, respiratory, digestive, genitourinary, others); and unknown/unspecified causes.**

Beginning in 1983, a pre-existing ICD-9 code (ICD-9 No. 279.1, "deficiency of cell-mediated immunity") was adapted for HIV/AIDS and used through 1986.[20,21] In 1987, a more detailed set of codes (categories *042–*044) for HIV/AIDS was introduced, along with new procedures for assigning HIV/AIDS as an underlying cause.[9,22] In 1986, 52 percent of deaths among men 25–44 years of age which had any listing of HIV/AIDS on death certificates had HIV/AIDS assigned as the underlying cause; in 1987 this increased to 90 percent. For example, a death certificate that mentioned both HIV/AIDS and other diagnoses would be more likely to have HIV/AIDS classified as the underlying cause in 1987 than in 1986. We sought to minimize this discontinuity by considering HIV/AIDS and conditions in the AIDS definition as a single category.

We used the Taylor series method to calculate 95 percent confidence intervals (CIs) for ratios of death rates in 1987 compared to 1980.[23]

Estimate of the Number of HIV-related Deaths, 1987

To estimate the number of HIV-related deaths in 1987, we first determined the number of deaths with certificates that mentioned HIV/AIDS on multiple-cause listings. Among all other deaths, we next considered those with underlying causes identified in the above analyses as increasing in association with the HIV epidemic. For each of these causes, we defined baseline trends by fitting a least median of squares line to the logarithm of death rates for 1970–80.[24] Using this exponential decay model, we then estimated by extrapolation death rates and the number of deaths that would have occurred in 1987 (expected deaths) if baseline trends had remained unchanged. Because data for causes of death were based on a 50 percent sample for some states in 1972, we excluded 1972 from our calculations. Because a new version of the ICD was introduced in 1979, our model included a shift parameter representing the discontinuity that occurred from 1978 to 1979. For some causes, baseline rates during the 1970s were stable or essentially zero or had no consistent trend. When this occurred, we used rates in 1980 as the baseline for estimating expected deaths in 1987 (Table 3). We then calculated excess deaths as the difference between observed deaths (excluding those with certificates that mentioned HIV/AIDS) and expected deaths.

Results

Overall Trends

Deaths with HIV/AIDS or one of the conditions in the AIDS definition listed as the underlying cause increased from 583 (1.9 per 100,000 population) in 1980 to 10,248 (26.6/100,000) in 1987 for men ages 25–44 years in the United States (Figure 1). Such deaths represented 0.8 percent of 73,652 deaths to men ages 25–44 years in 1980 and 11.3 percent of 91,082 deaths in 1987. From 1980 to 1983, total death rates for young men declined from 235.8/100,000 to 212.1/100,000, respectively, and then rose 10 percent to 236.1/100,000 in 1987, returning to a level similar to the rate in 1980.

Among deaths due to HIV/AIDS or conditions in the AIDS definition, the distribution of causes shifted from 1980 to 1986, reflecting the emergence of HIV (Table 1). For example, non-Hodgkin's lymphomas accounted for over two-thirds of such deaths in 1980 but less than 10 percent in 1986. The distribution shifted again in 1987, reflecting implementation of new categories for HIV/AIDS (Table 1). For example, the number of deaths with conditions in the AIDS definition (e.g., *Pneumocystis carinii* pneumonia, Kaposi's sarcoma) assigned as the underlying cause declined from 1986 to 1987, while deaths assigned HIV/AIDS as an underlying cause increased sharply.

Of the 1,381 deaths with conditions in the AIDS definition (but not HIV/AIDS) assigned as the underlying cause in 1987 (Table 1), 136 (10 percent) also mentioned HIV/AIDS on multiple cause listings. In addition to the 8,867 deaths assigned HIV/AIDS as the underlying cause in 1987, there were 979 deaths with HIV/AIDS listed on death certificates but not assigned as the underlying cause. Among these 979 deaths, leading underlying causes were: infections not included in the AIDS definition, 25 percent; conditions in the AIDS definition, 14 percent; drug abuse, 9 percent; cardiovascular disorders (excluding infections and "cardiac arrest"), 8 percent; and lung cancer, 6 percent.

TABLE 1—Deaths with underlying Cause Including HIV/AIDS or Conditions in the AIDS Surveillance Definition, Men 25–44 Years of Age, United States. 1980, 1986, and 1987

Underlying Cause of Death	Number of Deaths 1980	Number of Deaths 1986	Number of Deaths 1987	Percent 1980	Percent 1986	Percent 1987
Deficiency of cell-mediated immunity/HIV/AIDS[a]	2	3,850	8,867	0.3	49.4	86.5
PCP[b]	9	1,632	219	1.5	20.9	2.1
Other AIDS Infections[c]	75	1,038	325	12.9	13.3	3.2
Kaposi's sarcoma	44	401	86	7.5	5.1	0.8
Non-Hodgkin's lymphoma	399	770	670	68.4	9.9	6.5
Encephalopathy	54	103	80	9.3	1.3	0.8
Wasting	0	0	1	0.0	0.0	0.0
Total	583	7,794	10,248	100.0	100.0	100.0
Deaths per 100,000 population (for Total)	1.9	20.5	26.3			

[a] ICD-9 No. 279.1 for 1980-1986 (adapted for HIV/AIDS during 1983-1986) and category *042–*044 for 1987 (see text).
[b] *Pneumocystis carinii* pneumonia.
[c] Includes other infections in national surveillance definition for AIDS.[10]

**A listing of codes is available on request from the lead author.

Death Rates and State AIDS Incidence

As expected, death rates for HIV/AIDS or for conditions included in the AIDS surveillance definition increased more in states with the highest AIDS incidence compared with other state groups, and by 1987 ranged from 56.7/100,000 (5,922 deaths) in the five states with the highest AIDS incidence to 8.8/100,000 (701 deaths) in the 21 states with the lowest AIDS incidence. In addition to conditions in the AIDS definition, five other categories for underlying cause-of-death had a divergence in rates from 1980 through 1987 for different state groups: infections not included in the AIDS definition, unknown/unspecified causes, drug abuse, blood disorders other than congenital coagulation defects, and other immune deficiency (Table 2). Mortality trends for the first three of these causes are shown in Figure 2 for states with the highest and lowest AIDS incidence (rates in states with intermediate AIDS incidence were intermediate). For one of these underlying causes, drug abuse, the death rate declined slightly (8.2 to 7.4/100,000) from 1986 to 1987 in the states with the highest AIDS incidence (Figure 2C); however, when multiple cause-of-death listings were used to include deaths with any mention of drug abuse, death rates for drug abuse increased in these states from 1986 to 1987 (19.0 to 22.4/100,000). This difference in trends between underlying and multiple causes-of-death appears to reflect a shift from 1986 to 1987 in the selection of HIV/AIDS or drug abuse as the underlying cause when both are listed on death certificates. For one other category, respiratory conditions (excluding respiratory infections), rates increased more in the highest AIDS incidence states by 1987 (Table 2), but the pattern of divergence for the years between 1980 and 1987 was less clear.

Among infections not included in the AIDS definition, death rates increased from 1980 to 1987 in each subcategory in states with the highest AIDS incidence, while no change, declines, or smaller increases were observed in states with the lowest AIDS incidence. Pneumonia and influenza was the subcategory with the highest death rate (predominantly "bronchopneumonia, organism unspecified" or "pneumonia, organism unspecified"), while the greatest relative increases were seen for septicemia and pulmonary tuberculosis (Table 2).

Death rates for drug abuse had a relative increase that was similar in the lowest AIDS incidence states as in the highest AIDS incidence states (Table 2); however, the absolute difference in rates between the highest and lowest AIDS incidence states widened from 2.7/100,000 in 1980 to 4.9/100,000 in 1987.

Among deaths due to blood disorders other than congenital coagulation defects, the increase in the highest compared with lowest AIDS incidence states was due primarily to unspecified coagulation defects, thrombocytopenia, and agranulocytosis. Among deaths due to non-infectious respiratory conditions, this increase was observed for deaths due to "pulmonary congestion" and "alveolar pneumonopathies."

The pattern of increasing death rates in states with the highest compared with lowest AIDS incidence was not observed for the other cause-of-death groups we examined. To determine whether causes of death not recognized using these categories had such a pattern, we further reviewed numbers of deaths in 1980 and 1986 using ICD-9 codes at the major subheading level (e.g., the first three digits of the four-digit ICD-9 codes), after excluding conditions which accounted for <25 deaths in the two years combined. This review did not identify additional underlying causes with this pattern, with the possible exception of diabetes mellitus, which increased slightly from 2.2/100,000 in 1980 to 2.9/100,000 in 1987 in the highest AIDS incidence states, while remaining stable during this period in the lowest AIDS incidence states.

Race-specific Trends

For both White and Black men, lowest overall death rates for the 25–44 year age group were in 1983. For White men, death rates declined from 204.8/100,000 in 1980 to 187.3/100,000 in 1983, then rose 9 percent to 204.1/100,000 in 1987. For Black men, death rates declined from 510.3/100,000 in 1980 to 431.6 in 1983, then rose 19 percent to 513.5/100,000 in 1987. In 1987, death rates for HIV/AIDS and conditions in the AIDS definition for men in this age group were 22.2/100,000 for

TABLE 2—Deaths Rates for Causes Increasing in Association with the HIV Epidemic, by State Group (excluding HIV/AIDS and conditions in AIDS definition), Men 25–44 Years of Age, United States, 1980 and 1987

	Highest AIDS Incidence States				Lowest AIDS Incidence States			
	Death Rate[a]				Death Rate[a]			
	1980	1987	Rate Ratio[b]	(95% CI)[c]	1980	1987	Rate Ratio[b]	(95% CI)[c]
Infections not in AIDS definition	7.63	11.74	1.5	(1.4, 1.7)	5.20	5.13	1.0	(0.9, 1.1)
Septicemia	0.46	1.65	3.6	(2.5, 5.1)	0.63	0.87	1.4	(0.9, 2.0)
Pneumonia, influenza	3.85	5.42	1.4	(1.2, 1.6)	2.53	2.27	0.9	(0.7, 1.1)
Pulmonary tuberculosis	0.32	0.85	2.7	(1.7, 4.2)	0.19	0.10	0.5	(0.2, 1.3)
Central nervous system	0.36	0.68	1.9	(1.2, 2.9)	0.22	0.23	1.0	(0.5, 2.0)
Heart	0.44	0.62	1.4	(0.9, 2.1)	0.28	0.31	1.1	(0.5, 2.0)
Others	2.20	2.52	1.1	(0.9, 1.4)	1.34	1.35	1.0	(0.8, 1.3)
Drug abuse	4.05	7.41	1.8	(1.6, 2.1)	1.33	2.53	1.9	(1.5, 2.5)
Blood disorders[d]	0.60	1.18	2.0	(1.4, 2.8)	0.60	0.83	1.4	(0.9, 2.1)
Other immune defects	0.05	0.94	19.3	(7.1, 52.5)	0.07	0.19	2.5	(0.9, 7.0)
Unknown/unspecified	4.40	13.66	3.1	(2.8, 3.5)	3.34	2.17	0.6	(0.5, 0.8)
Respiratory[e]	2.20	3.11	1.4	(1.2, 1.7)	2.10	2.19	1.0	(0.8, 1.3)

[a] (Deaths/100,000 population).
[b] Rate ratio = (Rate in 1987)/(Rate in 1980).
[c] 95% Confidence Intervals.
[d] Excludes congenital clotting defects.
[e] Excludes infections.

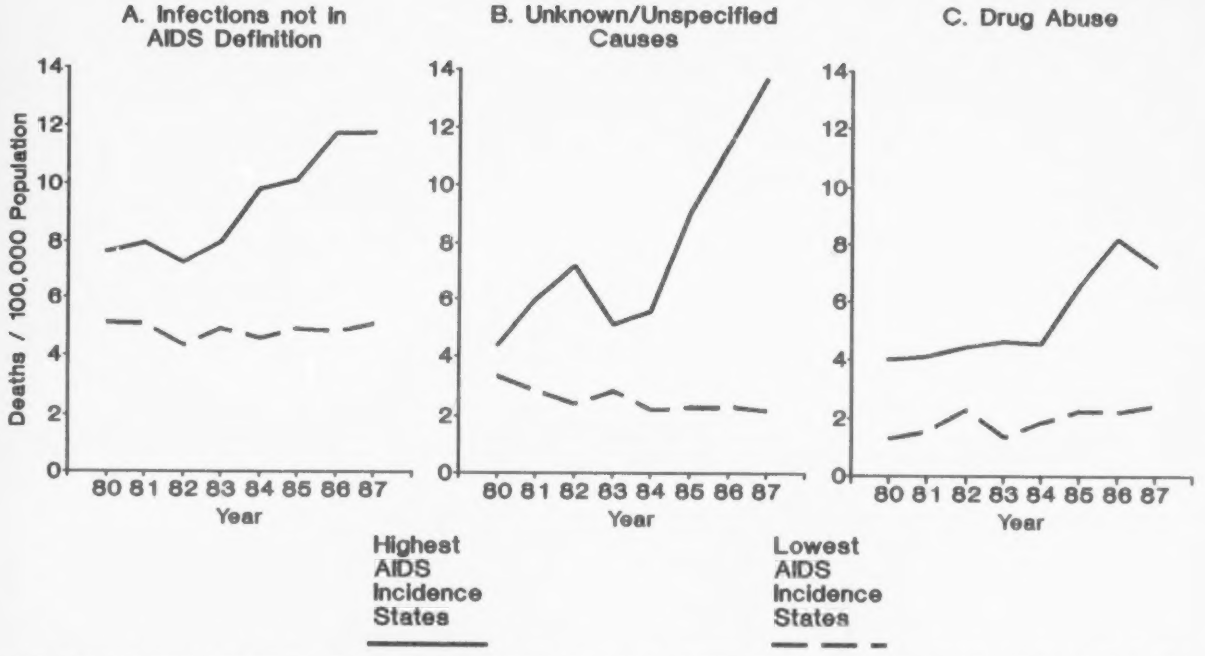

FIGURE 2—Death Rates per 100,000 Population, Men 25–44 Years of Age, Deaths due to Selected Causes with Rates that Diverged from 1980 to 1987 in the Highest Compared with Lowest AIDS Incidence States, United States, 1980–87

White men and 67.1/100,000 for Black men. For infections not in the AIDS definition, death rates increased from 4.2/100,000 in 1980 to 5.3/100,000 in 1987 for White men, and from 20.7 to 26.1/100,000, respectively, for Black men.

Estimate of HIV-related Deaths

In 1987, the estimate of HIV-related deaths in men 25–44 years of age ranged from 10,290 to 13,350, based on the number of excess deaths for those causes identified above as increasing in association with the HIV epidemic (Table 3). The model used for calculating excess deaths is illustrated in Figure 3 for pneumonia and influenza. The minimum estimate of HIV-related deaths (10,290 deaths) represents the number with mention of HIV/AIDS on death certificates and excess deaths due to conditions in the AIDS definition (Table 3). An intermediate estimate of HIV-related deaths, adding those due to infections not in the AIDS definition and other immune defects, is 11,470. The maximum estimate (13,350) includes excess deaths for all causes increasing in association with the epidemic. The 9,838 deaths with certificates that mentioned HIV/AIDS on multiple-cause listings represented 74–96 percent of estimated HIV-related deaths. This compares to 9,430 deaths occurring in 1987 among men 25–44 years of age and reported to national AIDS surveillance through December 1989, representing 71–92 percent of estimated HIV-related deaths for men in this age group.

In the absence of deaths due to HIV/AIDS and excess deaths due to these associated causes, the death rate in 1987 for men 25–44 years of age would have been 201 to 209/100,000, a decline of 11–15 percent from 1980 using the range of estimates of HIV-related deaths. Instead, death rates showed no net decline from 1980 to 1987.

TABLE 3—Estimate of HIV-related Deaths Men 25–44 Years of Age, United States, 1987

	Number of Deaths	Cumulative Total[a]
HIV/AIDS listed on death certificate	9,838	
HIV/AIDS not listed on death certificate, excess deaths with underlying cause[a]		
Other conditions in AIDS definition		
Pneumocystis carinii pneumonia[b]	210	
Other definition infections[c]	200	
Kaposi's sarcoma[b]	30	
Non-Hodgkin's lymphoma[c]	250	
Encephalopathy[d]	0	10,290
Infections not in AIDS definition		
Septicemia[c]	140	
Pneumonia & influenza[c]	680	
Pulmonary tuberculosis[c]	80	
Other infections[c]	250	
Other immune defects[b]	30	11,470
Drug abuse[d]	560	
Blood disorders[d,e]	80	
Unknown/Unspecified[d]	1,010	
Respiratory[b,f]	230	13,350

[a] Rounded to nearest 10 deaths.

[b] Death rate stable or near zero during 1970s, excess deaths estimated using rate in 1960 as baseline.

[c] Excess deaths estimated using trend during 1970s as baseline.

[d] Death rate had no consistent trend during 1970s, excess deaths estimated using rate in 1980 as baseline.

[e] Excludes congenital coagulation defects.

[f] Excludes infections.

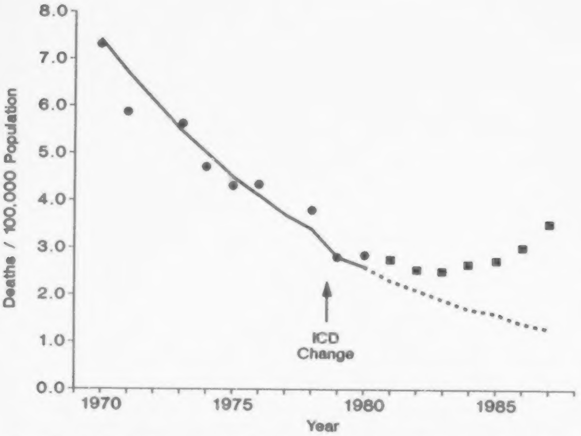

FIGURE 3—Death Rates per 100,000 for Pneumonia and Influenza, Men 25–44 Years of Age, United States, 1970–87
Circles represent observed rates for 1970–80. Squares represent observed rates for 1981–87 (excluding deaths with diagnoses coded as "deficiency of cell-mediated immunity, *Pneumocystis carinii* pneumonia or Kaposi's sarcoma in 1980–86 or as HIV/AIDS in 1987). Solid line represents baseline for rates in 1970–80 and dashed lines predicted rates for 1981–87.

Discussion

The HIV/AIDS epidemic has led to an increase in death rates for young men in the United States. Our findings are similar to those in England and Wales, where death rates have also recently increased in young men, primarily because of causes associated with HIV.[25] By 1987, deaths due to HIV/AIDS and conditions in the surveillance definition for AIDS accounted for more than 10 percent of deaths among men 25–44 years of age. Among Black men, death rates for these conditions were three times the rates for White men in 1987, reflecting disparities in AIDS incidence.[26] In addition, by comparing cause-specific mortality trends in states with high versus low incidence of AIDS, we have identified other causes of death that are increasing in association with the HIV epidemic.

Most notable is an increase in deaths due to infections that are not part of the surveillance definition for AIDS, such as pneumonia, septicemia, and pulmonary tuberculosis. This is consistent with clinical and epidemiologic observations that persons with HIV-related immune dysfunction are susceptible to a broad spectrum of infectious complications in addition to the "opportunistic" infections included in the AIDS surveillance definition.[27] Increases in morbidity and mortality due to these conditions have been noted most prominently in association with intravenous drug use,[28–31] although the risk of severe bacterial infections among HIV-infected persons is not limited to intravenous drug users.[32] The increase in deaths due to pulmonary tuberculosis is consistent with increases in tuberculosis noted in association with HIV and AIDS.[33–37]

The observation that deaths due to blood disorders such as agranulocytosis, thrombocytopenia, and unspecified coagulation defects increased in states with the highest AIDS incidence is consistent with recognized hematologic complications of HIV infection.[38] The finding that immune deficiencies other than cell-mediated immune deficiency (ICD-9 No. 279.1) are increasing is not surprising, given the spectrum of immune defects caused by HIV infection[39] and possible variations in the reporting and coding of HIV-related immune deficiencies.

The divergence in trends for deaths due to drug abuse in states with the high and low AIDS incidence probably reflects differences in both levels of illicit drug use and HIV infection among drug users, particularly in New York and New Jersey.[40] We cannot discern, however, to what extent the upward trend in death rates for drug abuse reflects trends in illicit drug use independent of the HIV epidemic. This possibility was considered but discounted by Stoneburner, *et al*, who studied mortality trends in New York City. While deaths in narcotic users increased from 1979 to 1986, overdose deaths did not increase, which should have occurred if narcotic use had increased.[28]

Similarly, for all causes that are increasing in association with the HIV epidemic, it is not possible to measure by death certificates alone what proportion of the increase is attributable to HIV infection. In some cases HIV infection may be unrecognized, and in others physicians may be unwilling to specify AIDS or HIV on death certificates. For example, the increase in deaths classified as due to "pneumonia" or non-infectious respiratory conditions may reflect the use of euphemisms for AIDS or *Pneumocystis carinii* pneumonia, or the lack of a full diagnostic evaluation. Likewise, the marked increase in deaths with unspecified cause in highest AIDS incidence states may reflect a failure to diagnose HIV infection or, alternatively, incomplete postmortem testing at the time of death certificate coding. Conversely, the categories we used for AIDS indicator diseases may capture some deaths that are unrelated to HIV infection. In 1980, over 500 deaths were due to conditions in the AIDS definition. While a few of these deaths may have been due to HIV infection, the majority most likely reflect the background occurrence of these conditions.

In addition to cancers in the AIDS definition, other cancers have had a suggested link to HIV infection.[11–19] We examined trends in deaths due to several of these cancers (Hodgkin's lymphoma, oral-pharyngeal cancer, anal-rectal cancer) but did not observe an increase in death rates or a divergence in trends for states with high and low AIDS incidence. This does not exclude an etiologic link between HIV and these conditions but suggests that if there is a link, it has not had a substantial effect on mortality trends. Similarly, population-based studies have not found statistically significant increases in the incidence of Hodgkin's lymphoma when high and low AIDS incidence areas were compared or when trends were examined for married and unmarried men.[41–44]

Increased rates of suicide among men with AIDS compared to other men have been described in New York and California.[45,46] Nationally, we observed that suicide and HIV/AIDS were listed together for 33 deaths in 1987, but we did not observe a difference in suicide trends for states with a high versus low AIDS incidence. This suggests that suicides among men with HIV infection has not had a substantial effect on suicide trends.

We have estimated that up to 13,350 HIV-related deaths occurred in 1987 among men 25–44 years of age, based on the number of deaths with HIV/AIDS listed on death certificates and on excess deaths for conditions that are increasing in association with the HIV epidemic. This estimate should be considered approximate for several reasons. We assumed that mortality trends during the 1970s would have continued unchanged during the 1980s in the absence of the HIV epidemic; for some causes we were unable to define a baseline trend in the 1970s; and some HIV-related deaths may be attributed to causes not included in our estimate.

New codes introduced in 1987 improve the classification of HIV-related deaths in national vital statistics. Nonetheless, our findings indicate that death certificates listing HIV/AIDS do not describe the full extent of HIV-related mortality. Similarly, our estimate of HIV-related deaths exceeds the number of deaths reported through national AIDS surveillance. Underreporting will affect both systems if HIV/AIDS is not diagnosed or if physicians are unwilling to report the diagnosis to health agencies. Also, HIV/AIDS may not be listed on death certificates in instances where physicians judge the cause of death to be unrelated to HIV infection. AIDS surveillance undercounts HIV-related deaths to the extent that AIDS cases and subsequent deaths are underreported and that persons with HIV-related disease do not meet surveillance criteria for AIDS. Thus, our estimate that 70–90 percent of HIV-related deaths in 1987 among men 25–44 years of age were detected by AIDS surveillance (which is somewhat higher than a comparable estimate for England and Wales[47]) indicates that reporting for those with disease meeting surveillance criteria must be at least this complete.

The concept of surveillance is increasingly being expanded beyond case reporting to encompass analyses of other data resources, such as vital statistics.[48] Comparison of mortality trends in areas with varying AIDS incidence provides a useful complement to AIDS surveillance in describing both the spectrum of conditions associated with HIV infection and the impact of the HIV epidemic on mortality trends.

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AAA Pedestrian Protection Program Names Four Safest Communities in 1989

The American Automobile Association recently released the results of its 51st annual Pedestrian Protection Program which recognizes communities and states that have made outstanding achievement in pedestrian safety. The four locations in America judged to be the safest places to be a pedestrian are: the State of Wisconsin; Henrico County, Virginia; San Jose, California; and Rocklin, California. According to Bill Bowes, AAA manager of community programs, "these communities have made strong efforts in traffic safety programs, including education at all levels of their population. They work hard at making sure their streets are safe."

The AAA Pedestrian Protection Program is designed to encourage cities and states to teach pedestrian safety and to strictly enforce related laws. Communities also work with AAA to improve their programs. The participating cities are grouped by population size and graded on safety programs, enforcement levels, traffic engineering, pedestrian deaths, and injury rates.

San Jose had a pedestrian death rate of 2.3 per 100,000 population and an injury rate of 54/100,000 in 1989. Comparable rates for the other winners were: Wisconsin, 1.4 deaths and 43 injuries/100,000; Henrico County, 1.9 deaths and 17 injuries/100,000; Rocklin, no deaths and 17 injuries/100,000.

Educational programs in schools and senior centers teach children, adults and senior citizens pedestrian safety. San Jose's active enforcement program led to 355 tickets issued to pedestrians crossing against traffic signals. Most pedestrians killed in the United States either violated traffic laws or behaved carelessly, AAA said. Since the Pedestrian Protection Program began in 1937, pedestrian fatalities have dropped from 15,500 per year to 8,800 in 1989. AAA also distributed a fact sheet about pedestrians, which included the following:

- The first recorded traffic fatality in the US occurred in 1899 in New York City. The victim was a pedestrian.
- The economic loss from pedestrian accidents in the US is estimated at more than $1 billion annually.
- At least 90 percent of all children injured enroute to or from school were struck where no type of special school crossing protection (safety patrols, adult guards, police officers) was in use.
- Pedestrians under age 15 and over age 64 account for 41 percent of all pedestrian fatalities; 17 percent of pedestrian deaths and 37 percent of pedestrian injuries are to those under age 15; older adults account for 24 percent of pedestrian deaths and 10 percent of pedestrian injuries.
- Pedestrian deaths are three-fold greater than combined air, marine and rail transport deaths.

For further information, contact AAA, 1000 AAA Drive, Heathrow, FL 32746-5063. Tel: (407) 444-8000.

Premarital Screening for Antibodies to Human Immunodeficiency Virus Type 1 in the United States

LYLE R. PETERSEN, MD, CAROL R. WHITE, MT, AND THE PREMARITAL SCREENING STUDY GROUP*

Abstract: To evaluate premarital human immunodeficiency virus (HIV) screening as an approach to AIDS prevention in the United States, we determined the HIV antibody seroprevalence in marriage license applicants in eight areas by blinded testing of blood specimens routinely collected for syphilis serology. The seroprevalences were 0.0–0.4 percent in women and 0.0–1.1 percent in men. We also examined the impact of mandatory premarital HIV screening on marriage rates in Louisiana and Illinois. In 1988, after screening began, 9 percent and 16 percent fewer marriage licenses than in the previous two years were issued in Louisiana and Illinois, respectively. We estimated that mandatory premarital screening, if adopted nationally, would cost $167,230,000. We conclude that compared with other HIV prevention programs mandatory premarital screening would be expensive and would probably have a minor impact on the HIV epidemic. (*Am J Public Health* 1990; 80:1087–1090.)

Introduction

Mandatory premarital screening for human immunodeficiency virus type 1 (HIV-1) antibodies, a measure proposed to reduce heterosexual and perinatal transmission of HIV infection, would require testing of 2.4 million couples annually if adopted in every state.[1] Arguments for and against mandatory screening focus on public health, scientific, ethical, political, and financial considerations.[2–4] A recent analysis arguing that premarital screening would not be cost effective was based on HIV seroprevalence rates among blood donors because rates in marriage license applicants were unknown.[2] However, HIV seroprevalence may be lower in blood donors than in marriage license applicants because these two groups are demographically dissimilar[5,6] and persons at risk for HIV infection are actively discouraged from donating blood.[7]

To evaluate the use of premarital HIV screening as an approach to HIV prevention, we determined the HIV antibody seroprevalence in marriage license applicants in eight areas. In addition, we examined the impact of mandatory premarital screening on the number of marriages in Louisiana and Illinois.

Methods

Premarital syphilis and/or rubella serologic testing is required in 20 states. From November 1985 to December 1988, we conducted blinded (test results unlinked to personal identifiers) HIV seroprevalence studies using blood specimens submitted to local or state health department laboratories for mandatory premarital syphilis screening in Alabama, California (Alameda County and City of Long Beach only), Connecticut, Georgia, Mississippi, New Mexico (Bernalillo County only), and Oklahoma. Areas for the blinded surveys were chosen on the basis of availability of specimens and desire by local or state health officials for a blinded survey. In each blinded survey, excess sera were tested for HIV antibody after the routine syphilis serologic testing was performed and personal identifiers were removed. In some locations, limited demographic data were available. No sera were collected specifically for HIV antibody testing. In Alameda County, specimens were submitted by seven public health clinics; in the other locations, by private physicians, public health clinics, the Indian Health Service, and hospital laboratories. In California, marriage license applicants who had been living together for ≥6 months could choose an option (23 percent of applicants in 1987) not requiring syphilis testing.

For each blinded survey location, comparison HIV seroprevalence data were obtained from the US Department of Defense military applicant screening program[8,9] and adjusted to the national age and gender distribution of marriage license recipients reported to the National Center for Health Statistics (NCHS).[5] The cumulative incidences of acquired immunodeficiency syndrome (AIDS) in adults (≥13 years of age) from 1978 to 1988 were computed from surveillance data from the Centers for Disease Control (CDC) and population denominators from the 1980 census.

Louisiana and Illinois began mandatory premarital HIV screening on January 1, 1988. Because only positive results were reported to the Illinois Department of Public Health, statewide seroprevalence rates in applicants could only be estimated by comparing the number of reported seropositive applicants to the total number of marriage licenses issued in Illinois during 1988. A description of the Illinois program has recently been published.[10] HIV antibody test results were not reported in Louisiana. Although statewide seroprevalence in applicants could not be directly measured in either state, seroprevalence information was obtained from six blood centers within these states that offered HIV antibody testing as a service to marriage license applicants.

The impact of the Illinois and Louisiana mandatory screening laws on marriage rates was evaluated using final data on the annual number of marriages from 1980 to 1985[11] and provisional NCHS data from 1986 through 1988 for 49 states and the District of Columbia.[12]

From the AIDS Program, Center for Infectious Diseases, Centers for Disease Control, Atlanta, GA (Petersen and White); and the Premarital Screening Study Group.* Address reprint requests to Technical Information Activity, Division of HIV/AIDS, CDC, 1600 Clifton Road, Atlanta, GA 30333. This paper, submitted to the Journal September 25, 1989, was revised and accepted for publication January 11, 1990.

*The *Premarital Screening Study Group* includes: Robert A. Benjamin, MD, MPH, Alameda County (California) Health Services, Oakland; Patricia J. Checko, MPH, Connecticut Department of Health Services, Hartford; Frank B. Farrales, MD, Aurora (Illinois) Area Blood Bank; John R. Harkess, MD, and Jerry Kudlac, MS, Oklahoma State Department of Health, Oklahoma City; Harry F. Hull, MD, New Mexico Health and Environment Department, Santa Fe; Yuan S. Kao, MD, Charity Hospital Blood Bank at New Orleans, LA; Chester Kelly, MS, MPH, Illinois Department of Public Health, Chicago; George L. Leonard, MD, Tulane Blood Center, New Orleans; Rick C. Moody, BS, Alabama Department of Public Health, Montgomery; Keith Sikes, DVM, MPH, Georgia State Department of Health, Atlanta; Nancy D. Strahan, MPPA, Mississippi State Department of Health, Jackson; David E. Smith, MD, Blood Center for Southeast Louisiana, New Orleans; Hazel G. Wallace, DrPH, Long Beach (California) Health Department; Margaret E. Wallace, MHS, Louisiana Blood Center, Shreveport.

TABLE 1—Prevalence of Antibody to the Human Immunodeficiency Virus Type 1 in Marriage License and Military Recruit Applicants and Cumulative Incidence of AIDS, by State, County, or City

State	Date	Marriage License Applicants % Seropositive (No. Tested)				Military Recruits % Seropositive*			Adult AIDS Incidence†		
		Females	Males	Total	95 % CI	Female	Male	Total	Female	Male	Total
Alabama	11/87-1/88	NA	NA	0.21 (4694)	0.11, 0.40	0.09	0.16	0.12	29	256	136
California‡	11/85-8/87	0.25 (786)	1.09 (736)	0.66 (1522)	0.34, 1.25	0.23	0.74	0.48	50	1648	819
California§	3/87-8/87	0.00 (137)	0.00 (140)	0.00 (277)	0.00, 1.08	0.00	0.47	0.23	52	3128	1544
Connecticut	1/88-4/88	0.39 (761)	0.27 (733)	0.33 (1494)	0.12, 0.82	0.11	0.45	0.28	138	650	381
Georgia	10/87-10/88	0.17 (2893)	0.29 (2722)	0.23 (5663)	0.13, 0.40	0.06	0.58	0.32	38	662	342
Mississipi	2/88-12/88	0.00 (1167)	0.00 (1059)	0.00 (2226)	0.00, 0.13	0.01	0.15	0.08	20	208	109
New Mexico¶	12/87-6/88	0.00 (222)	0.32 (312)	0.18 (541)	0.01, 1.18	0.00	0.11	0.05	23	441	225
Oklahoma	3/87-7/88	0.07 (4161)	0.05 (3920)	0.06 (8144)	0.02, 0.15	0.00	0.17	0.09	14	251	128

*Age- and sex-adjusted to marriage license applicants, 10/85-6/88
†Cumulative incidence per 1,000,000 adult (≥13 years of age) population 1978 to 1988
‡Alameda County, 11/85–9/86 and 1/87–8/87
§City of Long Beach
¶Bernalillo County (Albuquerque), New Mexico

The potential cost of premarital HIV screening, if adopted nationally, was based on the estimated 2,389,000 couples who married in 1988.[12] Based on the fact that observed premarital applicant HIV prevalence rates were more similar to those of military applicants than to those of other national population groups tested for HIV (e.g., blood donors), we assumed that the national HIV seroprevalence rates in marriage license applicants were equal to national rates for military applicants age-adjusted to marriage license recipients (0.31 percent men, 0.10 percent women). We assumed the average cost of HIV testing and counseling would be $35. This cost was similar to overall cost estimates used by others[2,10] and slightly lower than the average cost of HIV counseling and testing in public sites funded by the CDC ($42 for seronegative and $92 for seropositive persons). The sensitivity and specificity of sequential EIA and Western blot were assumed to be 99.0 percent and 99.999 percent, respectively. The specificity of 99.999 percent was used because the false-positive rate of the sequential enzyme immunosorbent assays (EIA) and Western blot has been shown to be less than 1 in 100,000 under optimal quality assurance conditions.[13,14]

Specimens from the blinded surveys and the HIV screening performed at blood centers in Louisiana and Illinois were tested for HIV antibody by licensed EIA. Repeatedly reactive specimens from the Alameda County and Long Beach Health Departments were confirmed by immunofluorescence assay (IFA), and repeatedly reactive specimens obtained elsewhere were confirmed by Western blot. Specimens confirmed by Western blot were considered positive at the Tulane Blood Center and at the American Red Cross Blood Services Heart of Illinois Region (Peoria, IL) if p24, p31 and either gp41 or gp160 bands were present. At the other centers, at least two of the following three bands were required: p24, gp41, and gp 120/160. These two criteria have been shown to yield similar results in asymptomatic persons.[15]

Results

Blinded Premarital HIV Seroprevalence Studies

Seroprevalences were from 0 to 0.7 percent (Table 1). Gender-specific marriage license applicant HIV antibody prevalences were 0–0.4 percent for women and 0–1.1 percent for men. Data from New Mexico, Oklahoma, Connecticut, and Georgia indicated HIV seroprevalence may be highest in persons 20 to 39 years of age (Table 2). The observed HIV antibody prevalence in Black marriage license applicants was higher than that of non-Hispanic White applicants in Georgia (Table 3). Race-specific data were not gathered in other states except Oklahoma where the number of non-Whites was small.

States with Mandatory Premarital Testing

In Illinois, 16 percent fewer marriage licenses were issued in 1988 than the average in 1986 and 1987, the two years before mandatory premarital screening was instituted (Table 4). Correspondingly, the number of marriages increased by 7 percent in states surrounding Illinois (Table 4). In Louisiana, there were 9 percent fewer marriages in 1988 than in 1986 and 1987—similar to the 7 percent decrease in its surrounding states (Table 4). The decrease in Louisiana only occurred during the period of screening, however. Compared to similar periods in the two preceding years, the number of marriage licenses issued in Louisiana decreased by 19 percent from January to June when the law was in effect, but from July to December the number remained at levels similar to those of the two preceding years (+0.5 percent). In contrast, the number of marriages decreased during the first (−18 percent) and second (−14 percent) halves of 1988 in Illinois where the law was in effect for the entire year. The decrease in marriages in states bordering Louisiana was due entirely to a decrease in marriages in Texas, a state with a population nearly four times that of Louisiana.

In Illinois, a total of 80,490 marriage licenses were issued in 1988; 26 persons (0.02 percent of 160,980 persons) with

TABLE 2—Prevalence of Antibody to Human Immunodeficiency Virus Type 1 in Marriage License Applicants, by Age and Location, 1988

Age* (years)	% Seropositive (No. tested)			
	Oklahoma Mar 87–Jul 88	New Mexico† Dec 87–Jun 88	Connecticut Oct 87–Apr 88	Georgia Oct 87–Oct 88
12–19	0.00 (1644)	0.00 (47)	0.00 (55)	0.00 (727)
20–29	0.07 (4110)	0.00 (227)	0.41 (731)	0.27 (3003)
30–39	0.08 (1288)	0.64 (156)	0.53 (378)	0.26 (1159)
≥40	0.00 (874)	0.00 (82)	0.00 (250)	0.3[illegible] (665)

*1/228 persons with unstated age in Oklahoma was seropositive, 0/29 persons in New Mexico, 0/80 persons in Connecticut, and 0/109 persons in Georgia with unknown age were seropositive.
†Bernalillo County (Albuquerque).

TABLE 3—Prevalence of Antibody to Human Immunodeficiency Virus Type 1 in Marriage License Applicants, by Race/Ethnicity and Gender, Georgia, 1987–88

	% Seropositive (No. Tested)			
Race/Ethnicity	Women	Men	Total	95% CI
White, non-Hispanic	0.10 (1939)	0.11 (1845)	0.11 (3784)	0.04–0.30
Black	0.22 (915)	0.72 (829)	0.46 (1744)	0.21–0.94
Other	2.94 (34)	0.00 (43)	1.30 (77)	0.07–8.01

None of 58 persons with unstated race were seropositive.

TABLE 4—Number of Marriages in Illinois, States Bordering Illinois, Louisiana, States Bordering Louisiana, and All Other States,* 1986–88†

States	Average 1986–87	1988	Difference (%)
Illinois	95834	80490	−15344 (−16.0)
Border Illinois‡	159986	171052	+11066 (+6.9)
Louisiana	36714	33527	−3187 (−8.7)
Border Louisiana§	251988	234194	−17794 (−7.1)
Other States	1757026	1744556	−12470 (−0.7)

*Excluding Nevada and including District of Columbia.

†Based on provisional data from the National Center for Health Statistics. Final data may vary from provisional data.

‡Indiana (+11 percent), Wisconsin (+9 percent), Iowa (+7 percent), Missouri (+1 percent), Kentucky (+5 percent).

§Mississippi (+5 percent), Arkansas (+11 percent), Texas (−11 percent).

positive HIV antibody tests were reported. It is unknown how many of these seropositive persons were pairs.

Seroprevalences from six blood centers with HIV antibody screening services for premarital applicants in Louisiana and Illinois were 0.0 percent to 0.9 percent (Table 5). Nine of the 10 seropositive marriage license applicants identified from the six blood centers had partners who were also tested at the blood centers; all were seronegative.

National Premarital Screening Projections

A total of 9,795 persons (7,406 males and 2,389 females) of the 2,389,000 couples marrying would have HIV antibody if the seroprevalence in that population were the same as that for military applicants. At $35 per person screened, the cost would be $167,230,000. If the overall sensitivity and specificity of HIV testing were 99.0 percent and 99.999 percent, 9,697 persons (7,332 men and 2,365 women) would be correctly identified as seropositive at a cost of $17,246 per seropositive person detected. The overall predictive value positive of the sequential EIA and Western blot would be 99.5 percent under optimal quality assurance conditions. There would be 48 persons with false-positive test results.

Discussion

Observed marriage license applicant HIV seroprevalences varied considerably—from less than 0.1 percent in two states to 0.66 percent in Alameda County, California—and areas with high HIV antibody prevalences generally had the highest cumulative AIDS incidences. These data suggest that the national HIV seroprevalence in marriage license applicants is of the same order of magnitude of that in military applicants (0.21 percent [adjusted to the age and gender distribution of marriage license recipients]) than to that in blood donors (0.012 percent).[16] Our data should be interpreted with caution, however, as there were few marriage license applicants in some study locations, these locations were not randomly chosen, and the effect of selection biases could not be fully determined.

Our data from the blinded seroprevalence studies of specimens collected for routine premarital syphilis screening suggest that the seroprevalence in marriage license applicants was much higher than that indicated by our data and those of Turnock and Kelly[10] gathered from reporting of seropositive persons identified by mandatory screening in Illinois. The calculated seroprevalence (<0.02 percent) based on reporting in Illinois was half that found in the blinded study in Oklahoma, a state with a lower cumulative incidence of AIDS in adults (128 vs 203 per million adult population) and a lower HIV prevalence in military applicants (0.09 percent vs 0.24 percent). In addition, although the numbers of premarital applicants tested in the two Illinois blood banks reported here were relatively few, the observed seroprevalences were higher than the calculated statewide seroprevalence despite the fact that these two blood banks were located in relatively low AIDS incidence areas. These discrepancies could have been due to underreporting of seropositive persons to the Illinois Department of Public Health; moreover, persons who knew they were infected or were at increased risk for HIV infection might have deferred marriage or traveled to adjacent states to marry.

Marriage rates decreased in Louisiana and Illinois after the mandatory screening laws took effect. Although we could not determine what proportion of this decrease was due to HIV screening, in Louisiana, the decrease in marriages occurred only in the first half of 1988 when the screening requirements were in effect. In Illinois, the number of marriages increased in adjacent states, and others have shown that some of this increase was due to border crossing

TABLE 5—Prevalence of Antibody to Human Immunodeficiency Virus Type 1 in Marriage License Applicants Tested in Blood Centers, Illinois and Louisiana, 1988

				% Seropositive (No. Tested)	
Blood Center	Area Served	Charge per Test	Dates	Total	95% CI
Aurora Area Blood Bank	Aurora, IL/8 counties	$40	Jan–Dec	0.06 (1553)	0.00, 0.42
Am. Red Cross, Peoria	Peoria, IL	$20†	Jan–Dec	0.05 (1951)	0.00, 0.33
Louisiana Blood Center	Shreveport/11 parishes	$20‡	Jan–Jul	0.00 (539)	0.00, 0.55
Blood Center SE Louisiana	New Orleans/13 parishes	$15‡	Jan–Jul	0.06 (3371)	0.01. 0.24
Tulane Blood Center	New Orleans/2 parishes	None§	Jan–Jul	0.10 (1914)	0.40, 0.50
Charity Hospital	New Orleans	None§	Jan–Jul	0.90 (444)	0.29, 2.45

†Red Cross provided testing services for the Peoria County Health Department.

‡If applicant donated blood for transfusion; $5 at Louisiana Blood Center and $10 at Blood Center for SE Louisiana for EIA and WB.

§One partner required to donate blood for transfusion.

by Illinois residents to avoid screening.[10,17] These data suggest that the efficacy of mandatory screening in identifying seropositive persons may be less than expected, especially if alternatives exist, such as marrying in adjacent states.

Premarital HIV screening would undoubtedly have little overall effect on heterosexual and perinatal transmission because most unmarried adults are sexually active[18] (only 63 percent of first births in the United States are conceived within marriage)[19] a negative premarital antibody test does not guarantee that a person will remain seronegative throughout the duration of the marriage; some persons counseled after a positive antibody test may not change their sexual or childbearing behavior to negate the risk of future HIV transmission; and groups with high seroprevalence may be less likely to marry before heterosexual or perinatal transmission occurs. For example, in New York State, the HIV seroprevalence in Black childbearing women is over 10 times that of White women,[20] and national figures indicate that 74 percent of first births to Black women are nonmaritally conceived compared to 31 percent in White women.[19] Data suggest that 75 percent of children with perinatally acquired AIDS in New York City are born to unmarried women.[2] Therefore, premarital HIV screening cannot be considered a substitute for other public health strategies to reduce perinatal and heterosexual HIV transmission.

The cost of mandatory HIV screening, if adopted nationally, is likely to be high relative to other HIV prevention programs. We estimated the cost to be $167,230,000, nearly 80 percent as high as the $211,889,000 Congressional appropriation to CDC for all public health HIV control measures for fiscal year 1988. The average cost of identifying a seropositive person was estimated to be $17,246, compared to approximately $925 in public sites funded by CDC (unpublished data). The actual cost of identifying a seropositive person may be much higher than we estimated because persons at high risk for HIV infection may decline to marry or may travel to adjacent states to avoid the screening requirements. In Illinois, the actual cost was estimated to be $312,000 per seropositive person during the first six months of screening.[10] Although the cost of mandatory screening could be borne by marriage license applicants, the poor—likely to be at higher risk for HIV infection—may avoid screening because of the cost.[10] The benefit of mandatory premarital HIV screening on HIV prevention is unknown.

Alternative strategies for preventing heterosexual and perinatal HIV transmission include increasing the availability of drug treatment for intravenous drug users (IVDUs) and HIV counseling and testing of clients in drug treatment centers and of all pregnant women at increased risk for HIV infection.[21,22] In addition, several states have adopted voluntary HIV screening for marriage license applicants.[23] Marriage license applicants are required to receive information about HIV infection, risk behavior, measures to avoid transmission of HIV, and availability of HIV testing and counseling. The efficacy of this approach is unknown.

We conclude that the high cost of mandatory premarital screening relative to other public health programs, its uncertain efficacy in identifying seropositive persons and preventing heterosexual or perinatal HIV infection, and the fact that persons will travel to adjacent states to avoid screening do not appear to justify its institution.

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Hepatitis Transmission among the Sioux Indians of South Dakota

FREDERIC E. SHAW, JR., MD, CRAIG N. SHAPIRO, MD, THOMAS K. WELTY, MD, MPH, WILLIAM DILL, PHD, JAY REDDINGTON, MD, AND STEPHEN C. HADLER, MD

Abstract: Hepatitis A continues to occur in cyclical community-wide epidemics on the Indian reservations of South Dakota. In June 1985 a population-based serosurvey for viral hepatitis involving 120 households was conducted at the Pine Ridge and Rosebud Sioux Indian reservations in South Dakota. The serosurvey was performed shortly after a large hepatitis A epidemic on the Pine Ridge reservation in 1983–84, and immediately before a large hepatitis A epidemic on the Rosebud reservation in 1985–86. The overall seroprevalence for antibodies to hepatitis A virus (anti-HAV) was 76.2 percent (Pine Ridge reservation 80.5 percent, Rosebud reservation 72.0 percent, relative risk = 1.12, 95 percent confidence interval = 1.01, 1.24). For age groups 0 to 4 years, 54.2 percent and 36.1 percent of children were seropositive at Pine Ridge and Rosebud, respectively. Seropositivity rose rapidly with age; by age 40, more than 90 percent of persons at both Pine Ridge and Rosebud were anti-HAV positive. Only 1.1 percent of persons tested were positive for hepatitis B markers. Anti-HAV seroprevalence rates in both communities are similar to rates observed in developing countries. The surprisingly high anti-HAV seroprevalence among young children at Rosebud, where clinical hepatitis A had been virtually absent in the previous seven years, indicates that high-grade silent transmission was taking place during the interepidemic period. (*Am J Public Health* 1990; 80:1091–1094.)

Introduction

Hepatitis A is endemic among most Native American tribes in North America. Rates of hepatitis A in Native Americans in the United States are four to five times higher than national rates in recent years (Centers for Disease Control, unpublished data). Outbreaks of hepatitis A have been a problem on reservations of South Dakota for many years. In the past several decades, they have occurred regularly, usually in cyclical patterns. Typically, outbreaks appear every 7 to 10 years, each one lasting 6 to 24 months. Frequently, the outbreak cycle on one reservation does not coincide with the cycle on nearby reservations. Sometimes a large outbreak occurs at one reservation while a nearby reservation is quiescent.

Such a situation existed in 1985 at two adjacent Sioux reservations in South Dakota, Pine Ridge and Rosebud. At Pine Ridge, an outbreak of hepatitis A began in early 1983 and continued into 1984. It became quite large, eventually involving several hundred people. During the same time, the Rosebud reservation was in an interepidemic period. In late 1985, a large outbreak began at Rosebud and continued into 1986. A cross-sectional seroprevalence survey for viral hepatitis was conducted at the two reservations in June 1985, after the Pine Ridge outbreak but before the Rosebud outbreak. The results allow comparison of the hepatitis serologic profiles of a reservation in a postepidemic period with a reservation in an interepidemic period.

Methods

The Pine Ridge and Rosebud reservations lie in the rolling prairie hills of South Dakota, at the state's southern border with Nebraska. The 1985 population of Pine Ridge was 16,020; the population of Rosebud reservation was 8,473. The two reservations are divided into small villages, nine at Pine Ridge and 20 at Rosebud. The counties that make up the reservations are among the poorest in the United States as determined by per capita income. There is moderate interaction between the two communities, with occasional shared social events. Children from each reservation attend different schools. Due to the long time presence of Indian Health Service Hospitals, public health nurses, and local community health representatives, the level of hepatitis case reporting has been relatively complete at both reservations.

Epidemic Data

The data sources for hepatitis A incidence rates over two decades and for the epidemic curves of the Pine Ridge and Rosebud outbreaks were from notifiable disease reports collected by the South Dakota State Health Department. Only cases from the three largest counties in each reservation (Pine Ridge—Shannon, Jackson, Bennett counties; Rosebud—Todd, Mellette, Tripp counties) were included. Incidence rates and age-specific attack rates were calculated using 1980 US census data and intercensal population estimates.

Hepatitis Seroprevalence Survey

The geographical study area was defined as the largest villages on each reservation that together represented 75 percent of the population of each reservation: at Pine Ridge, four villages (Kyle, Oglala, Pine Ridge, and Wanblee), at Rosebud, 12 villages (Antelope, Black Pipe, Corn Creek, He Dog, Horse Creek, Parmalee, Ring Thunder, Rosebud, St. Francis, Soldier Creek, Swift Bear, and Upper Cut Meat). Using maps of each village divided into block areas, housing units were selected for study by simple random geographic sampling, 70 at each reservation. Empty or unoccupied houses were replaced with the next sequential house. Three visits to each house were made before it was classified as a refusal; refusals were not replaced. Each household selected was visited by a study team consisting of a primary investigator and a local nurse or community health representative. After obtaining consent, a questionnaire was administered to the household head asking about the age, sex, race, and clinical history of hepatitis of each household member. In addition, household characteristics were ascertained, including the number of rooms and the presence of indoor or outdoor water supply and toilet facilities. Blood specimens

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From the Hepatitis Branch, Division of Viral and Rickettsial Diseases, Center for Infectious Diseases, Centers for Disease Control, Atlanta, GA (Drs. Shaw, Shapiro, Reddington, and Hadler); the Aberdeen Area Indian Health Service, Public Health Service Indian Hospital, Rapid City, SD (Dr. Welty); and the Aberdeen Area Indian Health Service, Aberdeen, SD (Dr. Dill). Address reprint requests to Craig N. Shapiro, MD, Hepatitis Branch, Division of Viral and Rickettsial Diseases, Center for Infectious Diseases, CDC, Building 6, Room 154, Atlanta, GA 30333.

were obtained from all household members one year of age or older.

Laboratory Assays

Tests for immunoglobulin M antibody to hepatitis A virus (IgM anti-HAV) and total antibody to hepatitis A virus (anti-HAV) were performed by using commercially available enzyme immunoassays; tests for hepatitis B surface antigen (HBsAg), antibody to hepatitis B core antigen (anti-HBc), and antibody to hepatitis B surface antigen (anti-HBs) were performed by using commercially available radioimmunoassays (Abbott Laboratories, North Chicago, Illinois).

Statistical Analyses

Confidence limits for relative risk estimates were calculated using the formulas of Greenland and Robins.[1]

Results

Data from Recent Outbreaks

Hepatitis A has occurred cyclically for many years on Pine Ridge and Rosebud reservations (Figure 1). The epidemic curves of hepatitis A outbreaks on Pine Ridge and Rosebud reservations in 1983–86 are shown in Figure 2. Transmission was predominantly person-to-person. There was no evidence for a common source. The age-specific attack rates for the two outbreaks show that the age distribution of patients at Pine Ridge and Rosebud were very similar and that the highest rates of disease were for younger groups aged 5 to 9 years (Table 1).

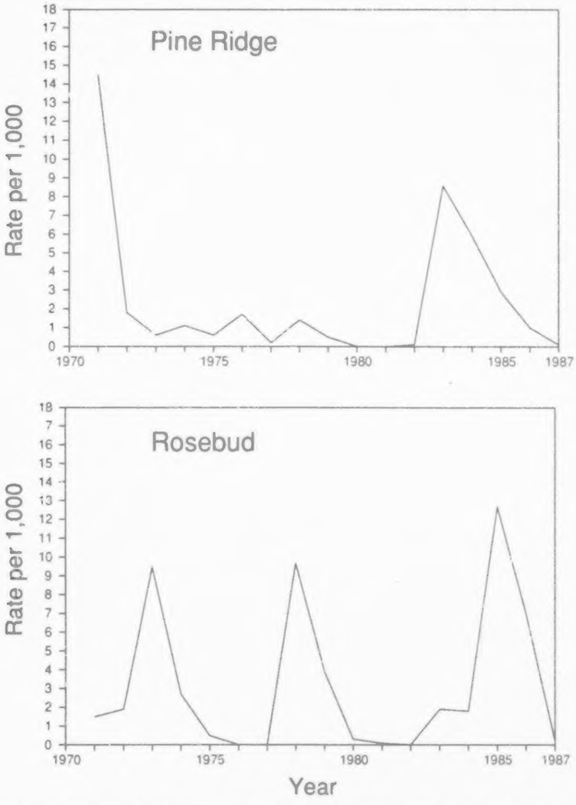

FIGURE 1—Hepatitis A Rates (per 1,000 population), Pine Ridge and Rosebud Reservations, South Dakota, 1971–87

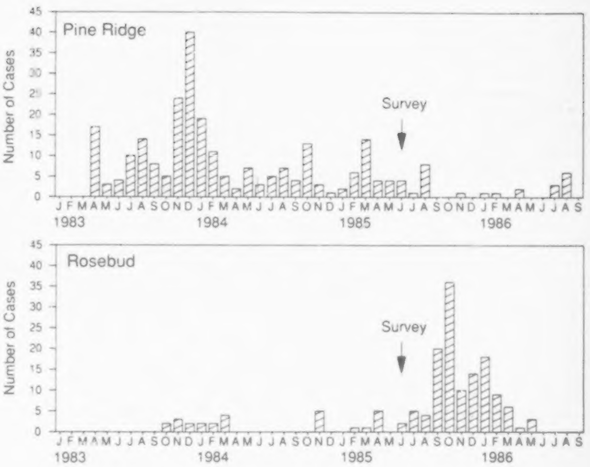

FIGURE 2—Hepatitis A Cases, by Report Date, Pine Ridge and Rosebud Reservations, South Dakota, January 1983 to September 1986

Hepatitis Seroprevalence Survey

Demographic Variables—The enrolled households numbered 120: 60 at Pine Ridge Reservation and 60 at Rosebud Reservation. A total of 605 persons lived in these households (Pine Ridge, 297; Rosebud, 308), for a mean of five persons per household (range, 1 to 16). The percentage of persons younger than 20 years of age who were in the study group did not differ substantially from the percentage in the 1980 census for the reservation areas (56.4 percent vs 53.1 percent, respectively), nor did the percentage of residents who were males (47.1 percent vs 49.7 percent, respectively).

Of the 605 persons, 590 were one year of age or older. Blood specimens from 467 persons were obtained and tested for hepatitis serologic markers. Demographic characteristics of the persons interviewed and tested are shown in Table 2. Characteristics of persons tested did not differ significantly from all household members identified.

Of the households visited, 93 percent had running water and 89 percent had flush toilets. The mean number of rooms per house was five.

TABLE 1—Age-specific Hepatitis A Attack Rates, Pine Ridge (1983–84) and Rosebud (1985–86) Reservations, South Dakota

	Pine Ridge 1983–84			Rosebud 1985–86		
Age Group (years)	Cases*	Population	AR**	Cases*	Population	AR**
0–4	64	2,064	15.5	49	1,274	19.2
5–9	87	1,972	22.1	70	1,142	30.6
10–14	34	1,895	9	13	1,041	6.2
15–19	8	1,817	2.2	11	902	6.1
20–24	8	1,294	3.1	7	744	4.7
25–29	5	1,046	2.4	5	653	3.8
30–34	3	900	1.7	2	512	2
35–49	1	1,648	0.3	5	969	2.6
50+	1	1,884	0.3	1	1,060	0.5
Total	211	14,520	7.3	163	8,297	9.8

*Native American cases reported to the South Dakota Department of Health

**Attack rate per 1000 population per year among Native Americans

TABLE 2—Demographic Characteristics and Anti-HAV Prevalence, Pine Ridge and Rosebud Reservations, South Dakota, June 1985.

	Interviewed		Tested		Anti-HAV	
Demographics	N	(%)	N	(%)	Prevalence	RR (95% CI)*
Age (years)						
<20	336	(56.4)	243	(52.0)	63.4	1.42 (1.29, 1.58)
20≧	260	(43.6)	224	(48.0)	90.2	
Sex						
Male	281	(47.1)	214	(45.8)	82.2	1.04 (0.94, 1.16)
Female	316	(52.9)	253	(54.2)	79.0	
Race						
Indian	586	(98.2)	456	(97.6)	76.5	1.97 (1.36, 2.84)
White	11	(1.6)	11	(2.4)	63.6	
Born on Reservation						
Yes	461	(79.1)	351	(76.0)	82.3	1.22 (1.07, 1.40)
No	122	(20.9)	111	(24.0)	69.4	
History of Hepatitis						
Yes	32	(5.4)	28	(6.4)	100	1.37 (1.13, 1.66)
No	564	(94.6)	411	(93.6)	73.2	

*Relative risk, 95 percent confidence interval, within each category

Serologic Results—At both reservations combined, 76.2 percent (356/467) of persons tested were positive for anti-HAV. The prevalence rate at Pine Ridge was slightly higher than at Rosebud (80.5 percent vs 72.0 percent, relative risk [RR] = 1.12, 95 percent CI = 1.01, 1.24). Seropositivity rates of individual villages within each reservation were roughly comparable (Table 3). Rates in males were not significantly different from rates in females at either Pine Ridge (82.2 percent males vs 79.0 percent females, RR = 1.04, 95 percent CI = 0.92, 1.18) or Rosebud (73.8 percent males vs 70.5 percent females, RR = 1.05, 95 percent CI = 0.89, 1.23). Of the 11 Whites tested, seven (63.6 percent) were positive, compared with 349 (76.5 percent) of 456 Native Americans. Of the 356 persons positive for anti-HAV, 10 (2.8 percent) were also positive for IgM anti-HAV, indicating recent infection. Of these persons, seven were from Pine Ridge, and three were from Rosebud; the range of ages was two to 41 years (median 7.5 years).

Anti-HAV seropositivity was strongly associated with age (Figure 3). At Pine Ridge and Rosebud reservations, respectively, 54.2 percent and 36.1 percent of children aged 0–4 years were anti-HAV positive (RR = 1.50, 95 percent CI = 0.84, 2.68). Prevalence rates at both reservations rose rapidly with increasing age, although more rapidly at Pine Ridge. By age 15, over 90 percent of persons at Pine Ridge were anti-HAV positive; rates did not reach 90 percent until age 30 years at Rosebud. In young adults ages 15–29, anti-HAV seropositivity was slightly higher at Pine Ridge than at Rosebud (91.1 percent vs 71.1 percent, RR = 1.28, 95 percent CI = 1.06, 1.54). Rates between reservations were not significantly different in adults ages 30 or more years (93.8 percent vs 91.6 percent, respectively, RR = 1.02, 95 percent CI = 0.94, 1.12).

TABLE 3—Anti-HAV Prevalence by Community, Pine Ridge and Rosebud Reservations, South Dakota, June 1985

Villages	Percent Antibody Positive (N Pos/N Tested)
Pine Ridge	
Pine Ridge Village	84.7 (61/72)
Oglala	83.1 (64/77)
Kyle	72.3 (34/47)
Wanblee	77.1 (27/35)
Total	80.5 (186/231)
Rosebud	
Parmalee	75.5 (40/53)
St. Francis	83.6 (46/55)
Rosebud	67.3 (35/52)
Swift Bear	59.6 (28/47)
Antelope	72.4 (21/29)
Total	72.0 (170/236)

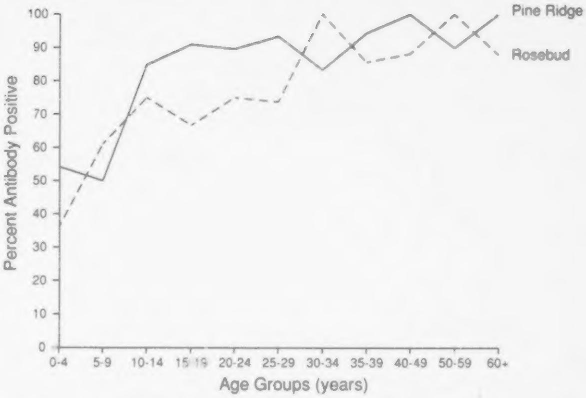

FIGURE 3—Anti-HAV Prevalence by Age Group, Pine Ridge and Rosebud Reservations, South Dakota, June 1985

Other personal characteristics which were examined included having been born on Pine Ridge or Rosebud reservation or having a history of hepatitis (Table 2). Persons born on one of the reservations were more likely to be anti-HAV-positive (82.3 percent vs 69.4 percent). Persons with a history of clinical hepatitis were also more likely to be anti-HAV-positive; this was true for persons at both Pine Ridge (RR = 1.30, 95 percent CI = 1.01, 1.68) and Rosebud (RR = 1.42, 95 percent CI = 1.07, 1.90).

Only five persons were positive for hepatitis B markers: four were immune (anti-HBc and anti-HBs positive) and one was HBsAg positive. Two persons were members of the same family—a 13-year-old boy who was HBsAg-positive, and his mother who was anti-HBs positive. The mother had acute hepatitis 13 years previously, while living off the reservation, during the third trimester of her pregnancy.

Discussion

The seroprevalence results presented here show that hepatitis A is widespread in the Pine Ridge and Rosebud reservation populations. In age groups over 30 years, 80 to 100 percent of persons have anti-HAV antibodies, indicating previous infection. These seroprevalence rates are much higher than those observed in the general U.S. population and in blood donors, in whom rates among adults are generally below 50 percent.[2] High rates of hepatitis A infection among Native Americans are due in part to poor environmental conditions and conditions related to poverty on many reservations, including crowded living quarters, inadequate housing, poor sanitation, and lack of running water.

A striking finding of this study was the high anti-HAV seroprevalence rate in young children at the Rosebud reservation (36 percent of children ages 0 to 4 years) even though Rosebud was in an interepidemic period and the last epidemic had occurred in 1978. These rates are very much higher than observed among children in other US settings,[3,4] and are comparable to rates in children in underdeveloped countries, where hepatitis A is endemic rather than epidemic.[5,6] Similar high hepatitis A seroprevalence rates among children in interepidemic periods have been observed among the Navajo in New Mexico.[7] In contrast, other studies in settings with cyclical epidemics suggest that transmission in interepidemic periods essentially ceases.[8,9] It appears that on these Indian reservations, at least, a significant amount of disease transmission occurs even in the absence of recognized epidemics, and the transmission is primarily among young children who have the lowest clinical/subclinical disease ratio.[10] Factors that cause this interepidemic transmission to lead to epidemic transmission are still poorly defined. A possibility is that transmission occurs constantly and silently, primarily among younger age groups, who serve as a reservoir for HAV infection; epidemic transmission may supervene periodically when a cohort of susceptible persons enlarges to a trigger level. An indication of this may be the somewhat lower anti-HAV antibody prevalence observed among children and young adults at Rosebud reservation, where an outbreak was about to occur, compared with Pine Ridge, where an outbreak had just occurred.

Another striking finding is the almost total lack of hepatitis B among Sioux Indians on Pine Ridge and Rosebud reservations. The only HBsAg-positive person, a 13-year-old boy, likely acquired the infection perinatally while his mother was living off the reservation. This lack of hepatitis B is consistent with low hepatitis B prevalence found among the Navajo and Hopi in northern Arizona.[11] In contrast, hepatitis B is endemic among Native Americans and Eskimos in Alaska.[12] It may be that behaviors or other factors that promote HBV transmission among Alaskan Eskimos are absent among Native Americans of the lower 48 states; alternatively, it may be that the hepatitis B virus (HBV) has never been introduced into the latter population.

Transmission of hepatitis A on reservations in the absence of outbreaks highlights the potential limitations of immune globulin (IG) as a control measure for hepatitis A in these settings. Furthermore, when community-wide outbreaks do occur, IG may not be effective in limiting the outbreaks unless it is given to the entire community simultaneously; this is rarely done because of impractical costs and logistics. Because IG does not confer immunity longer than about three months, in populations where hepatitis A occurs in large cyclical epidemics, mass use of IG might only delay the inevitable propagation to the whole susceptible community. Such a delay might result in a greater clinical disease burden; the inevitable infections might be shifted from young children, in whom infection is usually asymptomatic, to adults, in whom clinical illness is more likely.[13]

On Indian reservations, as well as in other parts of the United States, hepatitis A has significant human and economic impact, both in terms of morbidity and occasional mortality and in diverting of public health resources from other priorities when outbreaks occur. For the immediate future, outbreaks will probably continue to occur on the South Dakota and other Indian reservations. A safe, effective hepatitis A vaccine may be the only practical solution to control hepatitis A among Native Americans, and they are therefore a likely target population both for both vaccine testing and implementation. Several prototype vaccines have been developed, and are undergoing immunogenicity trials, with efficacy trials planned in the near future.[14-17] Until such a vaccine is available, conventional measures such as the promotion of handwashing, use of IG for household contacts of acute cases, and the improvement of general sanitation will remain important priorities.

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Teaching Status and Resource Use for Patients with Acute Myocardial Infarction: A new look at the indirect costs of graduate medical education

I. STEVEN UDVARHELYI, MD, TERRY ROSBOROUGH, MD, RICHARD P. LOFGREN, MD, MPH, NICOLE LURIE, MD, MSPH, AND ARNOLD M. EPSTEIN, MD, MA

Abstract: To investigate whether the process of graduate medical education increases costs in teaching hospitals by causing longer lengths of stay and greater resource use, we compared lengths of stay, hospital charges, and the use of cardiovascular procedures for patients with acute myocardial infarction admitted to the teaching and nonteaching services of a university-affiliated community hospital.

After adjusting for severity of illness and demographic characteristics, patients on the teaching services had a mean length of stay that was shorter by 0.6 days ($p = 0.04$) and mean charges that were \$2,060 lower ($p = 0.15$) than for patients on the nonteaching service. Patients on the teaching service also had 15 percent (95% CI: −26, −4) fewer cardiac catheterizations and 9 percent (−18, 0) fewer procedures for myocardial revascularization (angioplasty or cardiac bypass surgery).

These findings suggest that graduate medical education per se may not directly increase the use of health care resources and that the cost differences between teaching and nonteaching hospitals may be largely a consequence of other factors. These factors may include epiphenomena of teaching such as a specialized organizational structure, specialized patient care services, and continuing medical education for the nursing and medical staffs. They may also include factors not related to teaching such as differences in patients' severity of illness and sociodemographic characteristics. (*Am J Public Health* 1990; 80:1095–1100.)

Introduction

Medicare is currently providing teaching hospitals with supplementary payments to compensate them for the indirect costs of graduate medical education. However, as the government focuses on controlling costs these payments have become controversial.[1] Other third party payers also are concerned about the contribution of graduate medical education to rising health care costs.[2] There is little question that teaching hospital costs are greater than those of nonteaching hospitals. It is commonly thought that a substantial portion of this difference in costs is attributable to the educational process engendering greater resource use, both in terms of longer lengths of stay and increased use of diagnostic and therapeutic services.[2–10] Implicit in the scrutiny of the indirect costs of graduate medical education is an assumption that they may represent inefficiency or waste in health care.

Despite the prevailing belief that graduate medical education increases the use of medical services, this view is not universally accepted.[11] The findings of previous studies of this issue may be questioned for at least two reasons:

- Most of them evaluated the costs of graduate medical education for patients cared for prior to the focus on cost containment which became prominent after the introduction of prospective payment for Medicare.[2–10] The traditional academic concern to "be complete" has probably been modified by growing interest in cost-effectiveness and efficiency during the 1980s.
- Second, some investigators argue that the indirect costs of graduate medical education are merely a consequence of differences in severity of illness between patients cared for in teaching and nonteaching hospitals.[12–15] Even authors who argue that severity of illness does not account for the cost differential between teaching and nonteaching hospitals acknowledge that adjusting for severity of illness and/or case-mix substantially decreases the magnitude of the cost differential.[3–5]

The present study re-examines the issue of indirect costs of graduate medical education and focuses specifically on whether a graduate medical education program fosters greater use of medical services and longer lengths of stay by comparing the teaching and nonteaching services of a single institution.

Methods

We compared lengths of stay, total hospital charges, and the use of cardiovascular procedures for patients treated for acute myocardial infarction in 1985 on the teaching and nonteaching services of a single hospital. We chose myocardial infarction as the "tracer" because it is a common disease, clinical indicators of disease severity are easily identifiable through chart review, and there are costly, disease-specific procedures for the diagnosis and treatment of coronary artery disease.

Setting

Our data derive from Abbott Northwestern Hospital, a private, secondary and tertiary care hospital with 780 beds staffed for adult patients. The hospital is affiliated with the University of Minnesota Medical School but has its own accredited internal medicine residency training program with 12 interns or residents in each year of a three-year program. Abbott Northwestern is not a member of the Council of Teaching Hospitals, and is considered a minor teaching hospital.

Description of the Training Program

The medical service was organized with a teaching and a nonteaching service, although there was no physical separation of the two services and all patients used the same nursing stations, ancillary services, etc. Attending physicians

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From the Department of Medicine (Division of General Medicine, Section on Health Services and Policy Research), Brigham and Women's Hospital; Department of Health Care Policy, Harvard Medical School; Department of Health Policy and Management, Harvard School of Public Health, Boston, MA; Department of Medicine, University of Minnesota; Department of Medicine, Hennepin County Medical Center; and Medical Education Office, Abbott Northwestern Hospital, Minneapolis, MN. Address reprint requests to Arnold M. Epstein, MD, Department of Health Care Policy, Harvard Medical School, 25 Shattuck Street, Parcel B, 1st Floor, Boston, MA 02115. This paper, submitted to the Journal August 31, 1989, was revised and accepted for publication February 12, 1990.

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admitted their patients to either the teaching or the nonteaching service, based on their own discretion, although beds on the teaching service were occasionally not available since the teaching service had a limited capacity. The attending physicians received the same reimbursement regardless of whether a patient was on the teaching or nonteaching service, so that there was no financial incentive involved in choice of service. Patients admitted to the nonteaching service were cared for solely by the private attending physicians, except in the rare case of medical emergencies, such as cardiac arrests, when residents were the only available physicians. Patients admitted to the teaching service were still the responsibility of the private attending physicians, although much of the decision-making was delegated to the teaching service ward teams. These teams were each comprised of an intern, a second- or third-year resident, a third-year medical student, and one of four internists who comprised the full-time teaching faculty. In their supervisory roles, the private attending physicians maintained routine contact with the teaching service ward teams through progress notes and informal meetings. The full-time teaching faculty conducted formal, bedside rounds after each admitting day (three hours per week per ward team), and each ward team had an additional two hours of teaching rounds per week with a separate "teaching-only" attending. These "teaching-only" faculty included internists and medical subspecialists who were not part of the full-time teaching faculty but who were part of the clinical teaching faculty of the University of Minnesota Medical School. Patient care on the teaching service was also supervised on a daily basis by three chief residents (in their 4th postgraduate year) assigned to the eight ward teams.

Facilities for Cardiac Care

Abbott Northwestern hospital had 73 critical care beds, 95 telemetry beds, a cardiac catheterization suite, and operating rooms for open heart surgery. Approximately 1,300 open heart surgeries and 900 percutaneous coronary angioplasties were performed each year at this hospital. The medical director of the critical care units was an internist who was not a cardiologist, and there were no standard orders or operating procedures that confined or limited the type of care that cardiac patients received. Patients could be cared for in the critical care units without a cardiologist attending and without a consultation from a cardiologist. Likewise, cardiac catheterization was performed under the direction of each individual cardiologist and not a catheterization laboratory director.

Patient Selection

We identified all patients discharged with a diagnosis of acute myocardial infarction (AMI) in 1985 from computerized discharge abstracts and reviewed the charts of these individuals. Of 325 patients with a discharge diagnosis of AMI we excluded 99 patients who had been transferred from another acute care facility because information concerning severity of illness could not be obtained consistently. We excluded 41 of the remaining 226 patients because chart review did not confirm a diagnosis of AMI (an elevated serum creatine kinase with a positive MB fraction, or sudden death within 24 hours of admission). Five patients with confirmed AMIs were excluded because complete information was not available for determining severity of illness. The final study cohort of 180 patients therefore included all patients directly admitted to the hospital in 1985 with a confirmed diagnosis of AMI for whom accurate severity of illness information was available. In analyses of hospital charges we included only 177 patients because charge data were not available for three patients.

Data Collection

Data were collected from chart review, computerized discharge abstracts, and the accounting office. All charts were reviewed by one of us (ISU) to collect information on age, race, sex, whether the attending physician was a cardiologist, and, if the attending was not a cardiologist, whether the patient was seen by a cardiologist in consultation. To assess the general severity of acute medical illnesses, each patient was classified by a modified APACHE II score.[16] Because age was a separate variable in our analyses we excluded points for age from the APACHE II score. We recorded the number of diagnoses listed on the discharge summary as an approximation of comorbid disease. To assess the severity of cardiac illness we noted whether each patient had a history of a previous AMI, whether there was evidence of congestive heart failure on admission, and whether during the hospitalization there was recurrent chest pain, shock, cardiac arrest, sustained ventricular dysrhythmia, or severe conduction system disturbance (2nd or 3rd degree atrioventricular block or severe bradycardia).

From the discharge abstracts and the accounting office, we obtained data on primary and secondary payor, mortality, length of stay, total hospital charges, and the use of the following cardiovascular procedures: percutaneous coronary angioplasty, coronary artery bypass surgery, cardiac catheterization, Swan-Ganz catheterization, temporary pacemaker placement, and echocardiograms. We used hospital charges as an estimate of costs. Unit charges were identical on the teaching and nonteaching services and therefore total hospital charges should be a good proxy for relative costs even if they are not equivalent to absolute costs. Because angioplasty and bypass surgery may be viewed as different methods of myocardial revascularization these two outcomes were also combined to form a composite variable. Three patients had coronary angioplasty fail and therefore had bypass surgery as well. These patients were counted as having only one episode of myocardial revascularization.

Data Analysis

Our primary goal was to compare procedure use, length of stay, and total charges between the teaching and nonteaching services. To adjust for potential confounding due to differences in severity of illness and demographic characteristics, we performed a two-stage analysis using propensity scores as described by Rosenbaum and Rubin.[17,18]

A "propensity score," defined as the probability of being on the teaching service as a function of the confounding variables, was calculated for each patient. Patients were then stratified by propensity score and outcomes were compared using the techniques for stratified data described below.

We used a logistic regression model to calculate the propensity scores as a function of 11 potential confounders: age, sex, type of insurance (health maintenance organization or other), history of previous myocardial infarction, APACHE II score, recurrent chest pain, congestive heart failure, atrioventricular block or bradycardia, shock, cardiac arrest or sustained ventricular dysrhythmia, and the number of comorbid diagnoses. There was a linear relationship between age and the probability of being on the teaching service, so age was used as a continuous variable in the model. Interaction terms added little to the predictive ability of the model and were excluded. The patients were then grouped into five strata on the basis of the probabilities derived from the logistic model. For example, as a function of their severity of illness and other characteristics, patients in the lowest stratum had on average a 23 percent chance of being on the teaching service while patients in the highest stratum had a 78 percent chance of being on the teaching service.

Summary estimates of differences in hospital charges, lengths of stay, and procedure use between the teaching and nonteaching service were calculated using weighted averages across the five strata based on propensity scores. These summary estimates are therefore average differences that are adjusted for differences in patients' severity of illness and demographic characteristics.

Average differences in mean length of stay and charges were estimated by weighting each stratum specific difference by the inverse of the variance of the difference.[19] Average differences in median length of stay and charges were estimated by weighting each stratum specific difference in median length of stay or charges by the number of observations in that stratum, thereby producing a standardized median difference.[19] A stratified Wilcoxon rank sum test was used to test significance since length of stay and charges did not have normal distributions.[20]

Adjusted differences in procedure and mortality rates were calculated as standardized rate differences, again using the number of observations in each stratum as the weight, because several strata had marginal totals of zero.[19] Ninety-five percent confidence intervals (CI) for these standardized rate differences were based on the chi-square test statistic.[19]

To determine whether differences in resource use between the teaching and nonteaching service could be due to differences in the number of patients on each service who had a cardiologist as their attending physician, or to differences in the frequency of consultation by a cardiologist on each service, we controlled for these factors in a separate analysis. In this analysis we added dichotomous variables representing the specialty of the attending physician (cardiologist or not) and whether a patient had a cardiology consultation (yes or no) to the logistic regression model defined above, producing a second propensity score model based on 13 potential confounders. Patients were again divided into five strata on the basis of propensity scores and the above noted techniques for stratified analysis were employed to calculate weighted averages for procedure rates, length of stay and charges.

To assess the importance of outliers, we repeated our analyses excluding four patients (all on the teaching service) who had a length of stay greater than the 1985 Medicare outlier limit, which was 35 days.

The 95 percent CI for all univariate comparisons were based on the chi-square statistic[21] for categorical variables and Student's t-distribution[21] for continuous variables.

Results

Patient Characteristics

The number of patients admitted to the teaching and nonteaching services, their clinical characteristics, and the percentages enrolled in health maintenance organizations, cared for by a specialist in cardiology or seen by a cardiologist in consultation, are indicated in Table 1.

Although age and sex distributions were similar for the two groups, patients on the teaching service were generally more ill. Specifically, they had more comorbid diagnoses and more frequently had congestive heart failure on admission, recurrent chest pain, and cardiac arrest or sustained ventricular dysrhythmia.

Severity of Illness and Resource Use

The univariate associations of severity of illness with procedure use, length of stay, total charges, and mortality are presented in Table 2. Generally, the severity of illness indicators were well correlated with resource use and therefore seem to be reasonable covariates to use when controlling for severity of illness in our analyses. The patterns of procedure use, length of stay, charges and mortality conform to conventional clinical wisdom.

Resource Use and Teaching Status

Procedure rates, length of stay, hospital charges, and mortality on the teaching and nonteaching services are presented in Table 3. Patients on the teaching service had significantly fewer cardiac catheterizations and underwent myocardial revascularization less frequently. However, they had more frequent use of echocardiography. These differences persisted after adjustment for severity of illness and demographic characteristics. There was no difference in the

TABLE 1—Patient Characteristics

Characteristics	Teaching (N = 95)	Nonteaching (N = 85)	% Difference* (95% CI)
	mean ± SD		
Age (years)	73 ± 11	71 ± 14	2 (−1.7, 5.7)
APACHE II Score**	6.0 ± 4.4	5.8 ± 4.6	0.2 (−1.1, 1.5)
Number of comorbid diagnoses	7.4 ± 6.2	5.8 ± 4.5	1.6 (0.0, 3.2)
		% (N)	
Male	57 (54)	59 (50)	−2 (−16, 12)
History of myocardial infarction	28 (27)	28 (24)	0 (−13, 13)
Recurrent chest pain	51 (48)	41 (35)	10 (−5, 25)
Atrioventricular block or bradycardia	7 (7)	7 (6)	0 (−7, 7)
Cardiac arrest or sustained ventricular dysrhythima	25 (24)	16 (14)	9 (−3, 21)
Congestive heart failure on admission	75 (71)	52 (44)	23 (9, 37)
Shock	5 (5)	8 (7)	−3 (−10, 4)
Health maintenance organization members	37 (35)	40 (34)	−3 (−17, 11)
Cardiology attending	11 (10)	26 (22)	−15 (−26, −4)
Cardiology consult	55 (52)	45 (38)	10 (−5, 25)
Mortality	28 (27)	20 (17)	8 (−4, 29)

*differences are teaching minus nonteaching.

**the possible range is from 0 to 64, the actual range was from 0 to 23.

TABLE 2—Resource Use Related to Severity of Illness

Resource Use	Previous AMI		Recurrent Chest Pain		Congestive Failure		AV Block or Bradycardia		Cardiac arrest or Sustained Ventricular Dysrhythmia		Shock	
	present	absent	present	absent	present	absent	present	absent	present	absent	present	absent
Number	51	129	83	97	115	65	13	167	38	142	12	168
% Angioplasty	2	7	7	4	2	12	0	6	3	6	0	6
% Coronary bypass surgery	12	5	11	3	6	8	8	7	8	6	0	7
% Angioplasty or bypass surgery	12	10	16	6	7	17	8	11	8	11	0	11
% Cardiac catheterization	16	19	24	13	10	32	15	19	8	21	0	20
% Swan-Ganz catheterization	12	12	12	11	17	3	23	11	26	8	50	9
% Temporary pacemaker	6	11	11	8	12	5	31	8	26	5	25	8
% Echocardiogram	37	33	35	33	36	31	31	34	26	36	42	33
Mean length of stay (days)	10.1	10.5	12.5	8.6	10.7	9.8	6.9	10.6	7.4	11.2	6.2	10.7
($) Mean hospital charges	$11,038	10,065	12,943	8,143	10,942	9,277	11,673	10,234	10,807	10,221	10,658	10,317
% Mortality	35	20	27	23	34	8	62	22	79	10	92	20

use of Swan-Ganz catheterization or temporary pacemakers between the two services.

Before adjusting for severity of illness and demographic characteristics there were equivocal differences in length of stay between the two services; the teaching service had a higher mean length of stay but a lower median length of stay. After adjustment, the teaching service clearly had shorter lengths of stay. For hospital charges, patients on the teaching service tended to have higher charges before adjusting for severity and demographic characteristics, but this pattern reversed after adjustment for these factors.

The differences in length of stay and hospital charges persisted when outliers were excluded from the analysis. The adjusted mean length of stay for patients on the teaching service was 1.1 days shorter and the adjusted median length of stay was 0.5 days shorter (p = 0.009). Adjusted mean charges were $2,257 less and adjusted median charges were $1,653 less (p = 0.07).

The differences in resource use between the teaching and nonteaching services also persisted when we controlled for the specialty of the attending physician (cardiology or other) and whether a patient was seen in consultation by a cardiologist. The teaching service still had a lower use of cardiac catheterization, i.e., −11 percent (95% CI: −22, 0), and tended to have less myocardial revascularization, i.e., angioplasty −3 percent (95% CI: −8, 2); coronary bypass surgery −3 percent (95% CI: −11, 5); either −5 percent (95% CI: −13, 3). Controlling for these same variables minimized differences in lengths of stay and hospital charges. The teaching service had an adjusted mean length of stay that was 0.1 days shorter and an adjusted median length of stay that was 0.5 days shorter (p = 0.09). Adjusted mean charges were $16 higher on the teaching service, while adjusted median charges were $508 lower on the teaching service (p = 0.46).

Despite differences in resource use, in-hospital mortality on the two services was comparable. After adjusting for demographic characteristics and severity of illness, patients on the teaching services had a mortality rate that was 4 percent (95% CI: −10, 18) higher than for patients on the nonteaching service.

TABLE 3—Resource Use Related to Teaching Status

	Teaching (N = 95)	Nonteaching (N = 85)	crude difference*	adjusted** difference (95% CI)
	% (N)	% (N)	%	
Angioplasty	2 (2)	9 (8)	−7	−6 (−12, 0%)
Coronary bypass surgery	5 (5)	8 (7)	−3	4 (−11, 3)
Angioplasty or bypass surgery	6 (6)	15 (13)	−9	−9 (−18, 0)
Cardiac catheterization	11 (10)	27 (23)	−16	−15 (−26, −4)
Swan-Ganz catheterization	13 (12)	11 (9)	2	0 (0, 0)
Temporary pacemaker	9 (9)	9 (8)	0	−2 (−31, 27)
Echocardiogram	41 (39)	26 (22)	15	14 (0, 28)
Length of stay (days)				
mean ± SD	10.6 ± 7.8	10.2 ± 5.4	0.4	−0.6
median	9	10	−1.0	−1.2
p***			0.27	0.04
Hospital charges ($)				
mean ± SD	$10499 ± 9501	10164 ± 7611	335	−2060
median	$7544	7459	85	−1469
p***			0.73	0.15

*all differences are teaching minus nonteaching

**adjusted for: age, gender, insurer, previous MI, recurrent chest pain, congestive heart failure, AV block or bradycardia, cardiac arrest or sustained ventricular dysrhythmia, shock, APACHE II score, and number of comorbid diagnoses

***p-values are for differences between teaching and nonteaching services, based on the Wilcoxon rank sum test.

Discussion

Our data do not support the view that care on teaching services necessarily entails greater use of resources than care on nonteaching services, when adjusted for severity of illness. On the contrary, these data show that once adjustments were made for differences in severity of illness, patients on a teaching service had shorter lengths of stay and received a conservative type of care that used less cardiac catheterization and myocardial revascularization.

There may be several reasons why our results differ from those of previous investigators. First, our data were collected in 1985 and almost all previous studies have analyzed data collected prior to 1981.[2-10] We believe that emphasis on efficiency and "cost effectiveness" in academic medical centers is more common now than it was during the late 1970s and early 1980s. This may be especially true for the hospital we studied, since the Twin Cities has a very competitive health care market.

A second explanation may be that patients in teaching hospitals are more severely ill and much of this difference in severity may not have been controlled for by previous investigators using methods of DRG (diagnosis related group) case-mix adjustment. We used clinically relevant indicators of severity that were specific to one illness—acute myocardial infarction. The changes in patterns for length of stay and charges that we found before and after adjustment for severity of illness support the conclusion that there is significant variation in disease severity between teaching and nonteaching patients that may not be adequately controlled for by simple case mix adjustment.

A third explanation may be that the setting of our study allowed us to better isolate the effect of a teaching program on resource use. In our single hospital setting the primary difference between the teaching and nonteaching services was the presence of the teaching program and not other institutional or organizational characteristics. Results from previous studies which compared separate teaching and nonteaching hospitals may have been confounded by systematic differences between the two types of hospitals in terms of organization and other characteristics not directly related to teaching.[3,5,8,10] Even those previous studies which compared teaching and nonteaching services within a single institution may have been confounded by organizational differences since most studies evaluated physically separate patient care units.[2,4,6,7,9]

Certain characteristics of the decision-making process on the teaching services may also have influenced the pattern of procedure use we found. Before a patient on the teaching service underwent a procedure, the housestaff, teaching attending, private attending, and the cardiologist came to a working agreement on a treatment plan. It is possible that this interaction decreased utilization in a way analogous to mandatory second opinion programs.[23,24]

Nevertheless, there are several limitations to this study. First, patients were not randomly assigned to the teaching and nonteaching services and therefore differed in a variety of characteristics. It is possible that patients admitted to the teaching service were in other ways less "appropriate" candidates for procedures than patients on the nonteaching services. We did not have sufficient data to ascertain the appropriateness of, or indications for, individual procedures, but we did attempt to collect data on and control for those patient characteristics that correlated with and likely influenced patient management. Therefore, we feel that differences in procedure use between the two services are unlikely to be related to the severity of acute cardiac disease, and are more likely to be due to differences in practice style on the teaching and nonteaching services that are independent of disease severity. However, we cannot exclude the possibility that differences in unmeasured, clinically relevant characteristics between patients on the teaching and nonteaching services accounted for our results.

Second, it is possible that variations in the practice style of a few attending physicians accounted for our results. However, 71 attending physicians had patients in our study and the mean number of patients per attending physician was 2.5 (range 1–11).

A third potential problem with our findings is that the records on the teaching and nonteaching services may have contained systematically different amounts and detail of information regarding severity of illness. The physician-reviewer who abstracted all the charts did not note such a discrepancy, especially for the parameters of severity and utilization that we collected. Therefore we do not feel that our findings are an artifact of chart completeness.

Finally, we decided to study only one hospital and one disease in an effort to control for as many confounders as possible. This limits our ability to generalize our results to other settings and other diseases. An analysis of the management of other illness which have less stereotyped patterns of care or which have fewer options for very specialized procedures may show different results. While it is also possible that the teaching service we studied may be atypical and not representative of teaching services at other types of institutions, we feel that the nature of the internal medicine training program we studied was very similar to that of most university-based programs. It is also likely to be representative of those found in other nonCOTH (Council of Teaching Hospitals) minor teaching hospitals which in total comprise approximately 72 percent of all teaching hospitals in the country and have 19 percent of all residents.[25] These nonCOTH minor teaching hospitals would therefore receive approximately 20 percent of Medicare's payments for indirect medical education.[26]

Overall, this study suggests that graduate medical education does not universally lead to longer lengths of stay and greater use of medical resources. It may therefore be unwarranted to equate the cost differences between teaching and nonteaching hospitals with nonessential clinical expenditures generated by graduate medical education. This does not imply that teaching hospitals have the same costs as nonteaching hospitals. Graduate medical education may lead to "indirect" costs that are associated with teaching such as floor space devoted to conference rooms, larger medical libraries, and support for teaching faculty. The presence of graduate medical education may encourage teaching hospitals to have more active programs for nursing education and continuing education for staff physicians. Teaching hospitals may also require a more sophisticated organizational structure and higher level of technical support because of the academic mission which leads to caring for patients who require extraordinarily specialized and highly technical care. Previous studies have shown that hospitals which accept a large number of transfer patients have higher average costs per case than hospitals receiving few transfer patients.[27] Teaching hospitals may constitute a large percentage of such hospitals because of specialized services that attract referrals. Other reasons for higher costs in teaching hospitals may not be directly related to graduate medical education at all.

For example, there may be important differences in the socioeconomic characteristics of patients in teaching hospitals that increase resource use and bad debt.[28]

Medicare's supplementary payment to teaching hospitals to cover the indirect costs of graduate medical education is already controversial and has been reduced by 30 percent since 1983. Further reduction is now under serious consideration. Other payers are also questioning the high costs of care in teaching hospitals. The results of this study suggest that these costs may not be a function of unnecessarily longer lengths of stay and greater use of health care resources. We postulate that much of the higher costs noted in teaching hospitals may now come from the overhead expense of providing and developing specialized services or from differences in the patient populations of teaching and nonteaching hospitals that are not accounted for in DRG case-mix adjustments. In order to institute proper reform of reimbursement for graduate medical education, further work is needed to define more accurately the components of graduate medical education that currently influence health care costs.

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Call for Presentations at 1991 Annual Conference of AHA Section for Psychiatric and Substance Abuse Services

The American Hospital Association Section for Psychiatric and Substance Abuse Services invites proposals for presentations at their annual conference, "Changes and Challenges, Management of Psychiatric and Substance Abuse Services." The conference, which will be held Jun 5–7, 1991 in Boston, attracts hundreds of multidisciplinary mental health professionals from hospital-based psychiatric and substance abuse programs.

Proposals for presentations are requested which address such topics as: cost-effective service delivery methods, state-of-the-art technology, quality assurance issues, treatment of special populations, and strategic planning, as well as others. The deadline for submitting proposals is October 1, 1990. For further information and a presentation application form, please call Rebecca Chickey, 312/280-6650.

The Effects of Workplace Health Promotion on Absenteeism and Employment Costs in a Large Industrial Population

ROBERT L. BERTERA, DRPH

Abstract: We evaluated the impact of a comprehensive workplace health promotion program on absences among full-time employees in a large, multi-location, diversified industrial company. A pretest-posttest control group design was used to study 41 intervention sites and 19 control sites with 29,315 and 14,573 hourly employees, respectively. Blue-collar employees at intervention sites experienced an 14.0 percent decline in disability days over two years versus a 5.8 percent decline at control sites. This resulted in a net difference of 11,726 fewer disability days over two years at program sites compared with non-program sites. Savings due to lower disability costs at intervention sites offset program costs in the first year, and provided a return of $2.05 for every dollar invested in the program by the end of the second year. These results suggest that comprehensive workplace health promotion programs can reduce disability days among blue collar employees and provide a good return on investment. (*Am J Public Health* 1990; 80:1101–1105.)

Introduction

Health education has significant potential for reducing risk factors.[1-13] The effectiveness of workplace health promotion programs in reducing health risks has been demonstrated in the areas of high blood pressure control[14-16] and smoking cessation.[17-19] The evidence is more tentative in other areas of lifestyle change.[20-35]

Health education in the workplace is growing rapidly, driven by the promise of providing several non-economic,[33,36-38] as well as economic benefits.[18,38-44] Some authors emphasize the need for cost benefit and cost effectiveness analyses in order to examine the cost-effectiveness of workplace health promotion.[18,37,40,41,45] Others point out the limitations to the existing literature.[38,39,41]

The purpose of this study was to evaluate the impact of a comprehensive workplace health promotion program on illness absences not related to occupational causes.

Methods

Program Description

The program includes five core elements: training for site coordinators; a Health Promotion Activity Committee (HealthPAC); Orientation and Publicity; Health Risk Appraisal; and a variety of self-directed and group health education opportunities. These were first pilot tested in 1981 and 1982 at two manufacturing locations, refined, and then offered at the 41 intervention sites beginning in late 1983 and early 1984.

The program is introduced and administered by a network of site and departmental coordinators. Approximately 60 percent of these individuals are non-medical personnel selected for their communication skills, interest in health enhancement, and organizational abilities; in most cases, they serve part time in conjunction with their regular jobs. The remaining 40 percent are site medical personnel including nurses, physicians, and physician assistants.

At each location, a Health Promotion Activity Committee (HealthPAC) consisting of five to 15 employees from all levels of the organization assists in planning, publicity, and implementation.

The corporate health promotion staff offers a variety of three-day workshops designed to provide program guidelines, materials, and support for coordinators and HealthPACs. A quarterly newsletter keeps coordinators, committee members and management informed about site activities, new programs, and progress toward program objectives.

All program participants complete a voluntary, computer-scored health risk survey (available on request to author) containing 36 items on health status, personal habits, and lifestyle. Assistance is provided for interpreting appraisal results in groups using a videotape explanation, and individually through consultation with site medical personnel for all employees who request it. A copy of the appraisal is filed with the medical record for review during periodic medical evaluations which are offered to all employees at one, two, or three year intervals, based on age.

Health promotion activities include a variety of group and self-directed opportunities. Four- to 10-week class cycles provide opportunities at lunchtime or after shift to raise awareness or learn new skills. Topics for group and self-directed programs include smoking cessation, fitness, weight control, lipid control, stress management, and healthy back.

All employees receive a bi-monthly health and fitness magazine that helps keep employees and family members informed about current health and wellness developments. Challenges and incentive programs attempt to involve large numbers of employees in fitness, weight control, and smoking cessation activities. Cafeterias and vending machines offer heart healthy foods. Employees can check and record their own blood pressure and weight at machines and scales located in high traffic locations.

Certain program components were offered on company time including: program orientation activities, Health Risk Appraisal meetings, individual counseling, and health promotion activities presented to employees during safety meetings. The time allowed for these activities varied from 30 minutes to three hours, depending on employee interest and site commitment to employee health improvement. All employees must attend regular safety meetings on company time. Some of these meetings introduce and reinforce topics important to employee wellness such as: stress management, dental health, weight control, fitness, healthy back, high blood pressure control, nutrition guidelines, and smoking cessation. Safety meetings usually occur at least monthly and last from 15 to 60 minutes.

Address reprint requests to Robert L. Bertera, DrPH, Manager, Health Promotion Programs, Employee Relations Department, Medical Division, N-11400, Du Pont Company, Wilmington, DE 19898. This paper, submitted to the Journal March 30, 1989, was revised and accepted for publication February 12, 1990.

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Program Costs and Benefits

Actual program costs, disability wage costs, and disability wage savings were analyzed for the baseline year and two program years. Health promotion program costs include all expenses in 1986 dollars for: staff and committee time; instructors and group leaders; educational materials; publicity and promotion; health risk appraisals; and recognition awards and incentives. Program costs did not include: office space and utilities; fitness equipment (only a few sites had any at the time of the study); and the value of employee time when attending activities during working hours.

Disability wage costs included actual wages and benefits paid to hourly employees in 1986 dollars for days of absence due to illness. Savings were calculated as the difference between disability wages paid at the end of the first and second program years subtracted from disability wages paid in the baseline year, prior to the program's introduction. Disability wage costs and savings exclude other costs that may be related to absenteeism such as health care claims and replacement worker expenses.

Study Population and Design

The study population consisted of hourly employees who were part of the US workforce in a large, diversified manufacturing company. White collar employees were excluded from the study because the major outcome measure—disability days due to non-occupational illness—was recorded only for hourly employees. The hourly workforce had the following characteristics: more than three-fourths (82.7 percent) male; 16.1 percent Black; and more than one-third (41.0 percent) were 40 or more years of age.

We used a pretest-posttest equivalent control group design.[46] Out of 100 locations that were providing comprehensive health promotion services, 60 were included in this study because they had at least 100 hourly employees on site. This excluded smaller sites from the study such as unit plants, warehouses, and transfer depots, as well as predominantly white collar locations such as sales offices, service units, and research centers. All study sites followed consistent policies on disability leave and reporting throughout the study. Although site-specific data on turnover rates were not available, the company has a long tradition of very low employee turnover.

The intervention sites consisted of 41 locations which elected to initiate the health promotion program by June 1985 and met the above inclusion criteria. All sites had to obtain prior approval to initiate the health promotion program by submitting a written implementation plan to the corporate health promotion manager. This review process made it possible to identify the study's control sites. The control sites consisted of 19 locations that had not adopted the program by June of 1985.

The two study groups were compared for equivalence on a number of demographic and social characteristics at baseline. The 41 program sites did not differ significantly from the 19 non-program sites in terms of the average number per site of: employees; males; employees 40 years of age or older; or the total number of hourly or salaried employees (Table 1).

The analysis is based on absenteeism data from 43,888 hourly employees from January 1984 through December 1986. The 41 program sites employed 29,315 hourly employees while the 19 non-program sites employed 14, 573 hourly employees.

TABLE 1—Demographic Profile Of Hourly Employees at Health Promotion Program Sites vs Non-program Sites

	Study Groups[b]	
Mean Number per Site[a]	Program Sites (N = 41)	Non-Program Sites (N = 19)
Total Hourly Employees	715	767
Males	582	625
Age 40 or Older	325	324
Total Number of Hourly Employees	29,315	14,573
Total Number of Employees (Hourly and Salary)	42,435	22,116

[a] Based on 1984 averages per site for hourly employees except where noted as totals for the study group.

[b] No significant differences by t tests, 2 tail, separate variance estimate.

Unit of Analysis and Measurement of Outcomes

The primary outcome variable, using the sites as units of analysis, was the annual mean number of disability days per hourly employee. Days lost due to disability is defined as a measure of absenteeism that includes all illnesses not related to occupational causes. Disability days are recorded on time cards signed by supervisors and submitted to site time keepers for payroll purposes. Site disability days are reported quarterly to the corporate Compensation and Benefits Division which aggregates site data into annual reports.

Another outcome variable was the cost of wages, compensation, and benefits paid in 1986 dollars for days absent due to illness. For several years before this study began, all 60 study locations reported actual annual costs of wages, compensation, and benefits per hourly employee as part of an ongoing corporate accounting system separate from the health promotion program.

The health promotion program costs were obtained from two sources: 1) many items such as educational materials, supplies, health risk appraisals, and incentive awards were obtained from the corporate program, which provided expense records when sites were charged back for these goods and services; 2) sites were asked to submit annual budgets including information on staff and committee time. These sources were used to calculate the average annual program expenditures per hourly employee at each of the 41 intervention sites. The urban Consumer Price Index was used to convert health promotion program costs and disability wage costs into 1986 dollars and thus control for the effects of inflation from 1984 through 1986.

Results

The health promotion program began at the 41 intervention sites between November 1983 and June 1985. Most sites began the program in the first quarter of 1984; however, due to start-up delays, the program was actually available to employees an average of 20 months per site during the two-year study period.

Disability Days

As shown in Table 2, employees at program sites experienced a somewhat higher average number of days lost due to disability in the baseline year (1984). In the first year after the program was introduced (1985), the average number of disability days dropped 10.5 percent at program sites while it increased 1.9 percent at non-program sites.

TABLE 2—Mean Disability Days Lost by Hourly Employees by Program Year for Program and Non-program Sites

	Disability Days Lost by Study Group	
Year	Program Sites (N = 41)	Non-Program Sites (N = 19)
1984 (Baseline Pre-Program)	5.7	5.2
1985 (Year 1)	5.1	5.3
1986 (Year 2)	4.9	4.9
1984–1986 (decline)*	0.7	0.3

*Difference is 0.4 disability days (95 percent confidence interval 0.3, 0.5).

TABLE 3—Mean Disability Days by Hourly Employees Baseline Year (1984) vs Program Years One and Two for Sites with High vs Low Participation

	Disability Days Lost by Site Participation Level	
Year	High (N = 20)	Low (N = 21)
1984 (Baseline Pre-Program)	5.7	5.5
1985 (Year 1)	4.9	5.2
1986 (Year 2)	5.0	4.9
1984–1986 (decline)*	0.7	0.6

*Difference is 0.1 disability days (95 percent confidence interval 0.03, 0.23).

By the end of the second year, disability days dropped 14.0 percent at program sites and 5.8 percent at non-program sites. This represents 0.7 fewer disability days at program sites and 0.3 fewer days at non-program sites. The difference is 0.4 disability days per hourly employee (95 percent confidence interval 0.3, 0.5 days), which resulted in a savings of 11,726 fewer disability days at program sites compared with non-program sites over two years. This savings is the equivalent of 49 person years of effort that can be spent to produce goods and services.

The data suggest that the health promotion program had some influence on lowering disability days among hourly employees. It should be noted that other potential influences on disability statistics, such as early retirement programs and changes in medical insurance plans, were implemented simultaneously at both program and non-program locations during this period, thus providing some control for these external influences.

Disability Days by Participation Level

Although all 41 program sites met company health promotion guidelines (see Program Description, above), sites probably varied in the resources that they allocated to the program. Due to the number of sites, only limited anecdotal information was obtained in the course of the study to suggest resource variation as a confounding factor; one indirect indicator of how employees perceived the program was participation rates. Participation was measured by the number of employees who completed the Health Risk Survey form. Employees who completed the 36-item risk survey received a computer-scored Health Risk Appraisal within about 30 days.

Program sites where 50 percent or more of employees completed the Health Risk Survey had an average survey completion rate of 70.6 percent (CI = 69, 72), and are referred to as "High Participation" sites (N = 20). Program sites where less than 50 percent of employees completed the Health Risk Survey averaged only a 30 percent completion rate (CI = 26, 34), and are classified as "Low Participation" sites (N = 21).

One indicator that demonstrates differences in the intensity of program activity at high versus low participation sites was the variety of on-site classes offered. Sites that obtained a "high" response to the Health Risk Appraisal offered 6.2 topics, compared with 4.2 topics at low participation sites (difference 2.0, 95 percent CI = 1.56, 2.44).

As shown in Table 3, mean disability days declined in the first year by 14.0 percent at high participation sites and by 5.4 percent at low participation sites. By the end of the second year, disability days had declined 12.3 percent at program sites and 10.9 percent at non-program sites. This reflects a mean difference of 0.1 disability days (95 percent CI = 0.03, 0.23 days) between the two participation levels.

These data suggest that while higher participation was associated with greater declines in disability days in the first year, the association was not maintained in the second year. Table 4 indicates that there were about 50 percent more hourly employees at low participation than at high participation sites. It is possible that participation level was influenced by site size in a way that enabled smaller sites to gain higher participation and lower disability in the first year due to simplified start up logistics. By the second year, however, larger sites could have offered the program to more of their employees, thus reducing the first year differences that appeared to favor high participation sites. Another fact that supports this view is that indicators of participation were heavily dependent on first program year activity, again making it more likely that smaller sites would be classified as high participation sites.

Health promotion program costs were higher than in the first program year ($1.4 million) than the second year ($.7 million). This reflects higher initial investments of staff time, coordinator and committee time, training, publicity, and educational materials and incentives, some of which were not repeated in the second year. Savings due to lower disability costs were enough to offset program costs in the first year, where every dollar invested in health promotion yielded $1.11 in lower disability costs; in the second program year, every $1.00 spent on health promotion yielded disability savings of $2.05 (Table 5). Total return on investment over two years averaged $1.42 in lower disability wage costs for every $1.00 invested in health promotion.

TABLE 4—Demographic Indicators for Hourly Employees at Program Sites with Low vs High Participation

	Site Participation Level[b]	
Mean Number per Site[a]	High (N = 20)	Low (N = 19)
Total Hourly Employees	568	905
Males	446	759
Age 40 or Older	242	439
Total Number of Hourly Employees	11,927	18,110
Total Number of Employees (Hourly and Salary)	19,257	25,252

[a] Based on 1984 averages per site for hourly employees except where noted as totals for the study group.

[b] No significant differences by t tests, 2 tail, separate variance estimate.

TABLE 5—Program Costs and Disability Savings[a] by Program Participation Level and Year

Program Analysis	All Program Sites (N = 41 Sites)	Site Participation Level: Low (N = 21 Sites)	Site Participation Level: High (N = 20 Sites)
Year 1 (1985)			
Costs	$1,436,965	$ 736,031	$ 700,933
Savings	1,596,877	708,069	888,808
Return on Investment[b]	$1.11	$ .96	$1.27
Year 2 (1986)			
Costs	$ 714,312	$ 366,075	$ 348,237
Savings	1,463,524	641,632	821,891
Return on Investment[b]	$2.05	$1.75	$2.36
Combined (1985 & 1986)			
Costs	$2,151,277	$1,102,107	$1,049,170
Savings	3,060,401	1,349,701	1,710,699
Return on Investment[b]	$1.42	$1.22	$1.63

[a] All Costs and Savings figures are in 1986 dollars.
[b] Based on disability savings divided by program costs.

Total return on investment over two years varied by program participation level, with high participation sites saving $1.63 in lower disability costs for every dollar invested over two years, versus $1.22 for low participation sites (Table 5).

These return-on-investment data are conservative estimates because they exclude other potential savings that may be associated with lower absenteeism including lower costs for: company health care claims; replacement workers; and employee out-of-pocket health care expenses.

Discussion

Intervention sites self-selected themselves by initiating comprehensive employee health promotion activities prior to June 1985. This decision may have been linked to factors that could have predisposed self-selected sites to reduce disability days through means other than health promotion.

If present, this bias could lead to over-estimating the potential impact of the program. Future studies could control this potential bias by randomly assigning sites to intervention and control conditions.

The control sites consisted of 19 locations that had not adopted the comprehensive program by June 1985. However, a few of the 19 control locations may have initiated portions of the program after June 1985 and thus received partial interventions from July 1985 through December 1986. This potentially dilutes the intervention effect which may have been reflected in the second-year absenteeism declines for control sites, and probably produces an underestimate of the program's potential impact. No systematic information was collected on the nature or extent of potential control site contamination. The extensive communication networks and decentralized decision-making in a large, diversified company makes it difficult to measure and control such effects.

Disability days were tracked for three years including the baseline year. Longer follow-up periods would be desirable to measure maintenance effects. Unfortunately, the tracking system for disability days was discarded in 1987 as part of a restructuring of human services resources within the company.

Site employee participation levels were estimated by the number who completed the health risk appraisal. This is an indirect but convenient measure of perceived interest and quality. While some evidence exists that the number of activities offered on the site is related to the risk appraisal completion, future studies should seek additional information on program participation, activities, and expenditures. The measurement and attribution of potential program impacts could also be improved by obtaining information on geographic or intergroup variations of employee turnover, job satisfaction, and other measures of attitudes or beliefs that could affect absenteeism patterns.

Recent published reports, while not using absenteeism as an outcome, have reported savings associated with comprehensive health promotion programs in the workplace. In a study of Johnson & Johnson's comprehensive approach, inpatient hospital insurance costs compared to controls[47] were nearly $1 million lower over five years. These savings were attributed to lower rates of increase in the number of hospital days and in the number of admissions among employees at program sites.

In a study of a comprehensive health promotion and wellness education at Blue Cross-Blue Shield subscriber companies, employees with the program claimed 24 percent fewer health insurance dollars over five years compared to similar employees who were not receiving the program.[48] The savings in lower health care insurance costs produced a return on investments of $1.45 for each dollar spent on the program.

These studies and our results suggest that comprehensive workplace health promotion programs can return $1.45 in lower hospital insurance costs and another $1.42 in lower disability wage costs for every dollar invested in health promotion. If these findings can be confirmed in other studies, it appears that health promotion programs are good business because they provide a favorable return on investment while helping to improve indicators of health among blue collar employees.

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USEPA to Sponsor International Symposium on Radon

The United States Environmental Protection Agency has announced the dates for the International Symposium on Radon and Radon Reduction Technology will be April 2–5, 1991, in Philadelphia, Pennsylvania, and has issued a call for papers with the theme being 'A New Decade of Progress.'

The symposium will provide a forum for the exchange of technical information on radon and radon reduction technology in the indoor environment. The major topics considered for the symposium will be: experience in the development and application of radon reduction and radon-resistant construction techniques, the measurement of radon and radon progeny, and the assessment of radon-derived health impacts.

Topics of greatest interest are: Radon Control, Measurement Methods (air and soil), Health Issues, Foreign and Domestic Radon Programs and Policy Issues, Radon Surveys, Public Information and Education, Radon in the Natural Environment.

Abstracts of 150 words or less should be submitted by September 30 to: Timothy M. Dyess, US-EPA, AEERL/Radon Mitigation Branch, MD-54, Research Triangle Park, NC 27711. Papers should provide study results; however, theoretical discussions of concepts and mechanisms will also be considered. Abstracts will be screened by the sponsors and papers will be solicited to cover areas of special concern. Notification of acceptance of papers will be done by November 15, 1990, after which the author will be required to submit an original and five copies of the paper by January 31, 1991.

Caffeine-Containing Beverages, Total Fluid Consumption, and Premenstrual Syndrome

ANNETTE MACKAY ROSSIGNOL, ScD, AND HEINKE BONNLANDER, RN, MSN

Abstract: The main objective of this study was to evaluate whether daily consumption of caffeine-containing beverages is related to the prevalence and severity of premenstrual syndrome apart from any effects of daily total fluid consumption. A secondary objective was to determine whether daily total fluid consumption itself is related to premenstrual syndrome. The study is based on 841 responses to a questionnaire probing menstrual and premenstrual health, and daily fluid consumption, which was mailed to female university students in Oregon. Analysis of the data revealed that consumption of caffeine-containing beverages was strongly related to the prevalence of premenstrual syndrome. Among women with more severe symptoms, the relation between consumption of caffeine-containing beverages and premenstrual syndrome was dose-dependent, with prevalence odds ratios equal to 1.3 for consumers of one cup of a caffeine-containing beverage per day and increasing steadily to 7.0 for consumers of eight to 10 cups per day. The effects were apparent among both caffeine-containing tea/coffee consumers and caffeine-containing soda consumers. The observed effects were only slightly reduced when daily total fluid consumption was controlled. Daily total fluid consumption also was related to the prevalence of premenstrual symptoms although the effects were large only for consumers of 13–19 cups of fluid per day (the largest amount studied). (*Am J Public Health* 1990; 80:1106–1110.)

Introduction

Previous investigations have indicated that the consumption of caffeine-containing beverages is strongly related to the prevalence and severity of premenstrual syndrome (PMS), and that such effects exist for a wide variety of premenstrual symptoms.[1–4] Further work demonstrated that the association between premenstrual symptoms and consumption of caffeine-containing beverages occurs even among women who lack other putative causes of the syndrome.[5] Such putative causes included alcohol use, cigarette use, lack of exercise, oral contraceptive use, and a diet high in beef and refined sugar products.[6–18]

One possible explanation for the observed association between consumption of caffeine-containing beverages and premenstrual symptoms is that consumption of these beverages is related to daily total fluid consumption, and that it is daily total fluid consumption which is causally related to premenstrual symptoms. Such an explanation might be consistent with the retention of fluid experienced by many women who report premenstrual symptoms.

This study was undertaken to assess the relation between premenstrual syndrome and caffeine-containing beverage intake, and between premenstrual syndrome and total fluid intake, controlling for any confounding effects attributable to the other variable. In addition, we wanted to describe the dose-response relation between premenstrual syndrome and consumption of caffeine-containing beverages and of total fluid, and to discover which types of caffeine-containing beverages might exert an effect.

Methods

Study Population and Data Collection

The study was conducted at a public university in Oregon. Eligible subjects were the 1,419 currently enrolled, female students who resided in any of the university's residential dormitories.

In October 1988, each eligible student was sent a questionnaire, together with a cover letter explaining the general nature of the study (a study of women's health) and requesting her participation. The questionnaire solicited information about the presence and severity of premenstrual symptoms and of menstrual symptoms, demographic characteristics, use of over-the-counter drugs containing caffeine, and typical daily consumption of beverages including caffeine-containing beverages. The questions pertaining to premenstrual symptoms asked each respondent to indicate whether she experienced premenstrual symptoms and, if she did, to score the severity (mild, moderate, or severe) of each in a list of 10 premenstrual symptoms plus an "other symptom" category. To reduce the likelihood that the study participants would suspect the hypotheses under investigation, we included questions about menstrual health similar in number and detail to those probing premenstrual health. A definition of the syndrome, which emphasized the timing of symptoms with respect to the onset of menses, was included in the questionnaire.

The questions pertaining to daily beverage intake asked for the number of cups, defined on the questionnaire as "eight ounces, or one measuring cupful," of each in a list of 11 beverages plus an "other beverage" category the respondent consumed during a typical day. One of the 11 beverages was water.

Eight-hundred-and-sixty-nine women (61 percent) returned the questionnaire after two mailings. (The second mailing was conducted in January 1989.) The data for 28 women subsequently were excluded from the data analysis: two women reported having endometriosis, four women did not menstruate on a regular basis, and 10 women did not provide information on the presence of premenstrual symptoms or on the daily consumption of beverages. An additional 12 respondents were excluded because their daily consumption of caffeine-containing beverages was between 11 and 30 cups, making the cup-specific prevalence odds estimates unstable (as described in the section on data analysis). These exclusions left data on 841 women for analysis. Ninety-six per cent of these women were between the ages of 18 and 22 years.

From the Department of Public Health, Oregon State University. Address reprint requests to Annette MacKay Rossignol, Associate Professor and Chair, Department of Public Health, Oregon State University, Corvallis, OR 97331-6406. This paper, submitted to the Journal July 24, 1989, was revised and accepted for publication January 25, 1990.

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Data Analysis

We estimated the premenstrual syndrome prevalence odds ratios, the odds of having premenstrual syndrome among "exposed" women divided by the odds among "unexposed" women, for five levels of daily consumption of caffeine-containing beverages (one cup, two to four cups, five cups, six or seven cups, and eight to 10 cups) and for four levels of daily total fluid intake (six or seven cups, eight to 10 cups, 11 to 12 cups, and 13 to 19 cups). These intervals were determined empirically on the basis of the uniformity of the premenstrual syndrome prevalence odds ratio point estimates for each level of consumption within an interval. For the three subjects who used caffeine-containing drugs on a daily basis, the estimates of the number of cups of a caffeine-containing beverage consumed each day were increased. The amount of increase equaled the equivalent number of cups of a caffeine-containing beverage for the caffeine content of the drug. The equivalency was determined by the information provided on each drug's packaging material. There were too few subjects who reported consuming more than 10 cups of a caffeine-containing beverage each day, or more than 19 cups of total fluid each day, to provide information for higher levels of consumption. Daily total fluid consumption was calculated by summing the numbers of cups of beverages consumed each day for each of the 11 listed beverages plus the "other" beverage category.

Confidence intervals for the prevalence odds ratios were based on Miettinen's test-based procedure, using the programs of Rothman and Boice.[19]

The overall trend in the data relating premenstrual symptoms and caffeine-containing beverages intake, and premenstrual symptoms and total fluid intake, was tested using the method described by Mantel.[20] The method of maximum likelihood was used to estimate the slope, and standard error for the slope, for the logistic curve relating premenstrual syndrome and daily consumption of caffeine-containing beverages or daily total fluid intake.[21]

We assessed the magnitude of confounding of the premenstrual syndrome prevalence odds ratio by either daily consumption of caffeine-containing beverages or by daily total fluid consumption (depending upon which of these two variables was the variable of interest) by stratifying the data into categories of the potential confounding factor and obtaining an estimate for a uniform prevalence odds ratio by the method of maximum likelihood.[22] The categories used were identical to the categories formed by empirically determining the intervals over which the premenstrual syndrome prevalence odds ratio was uniform.

The level of severity of premenstrual syndrome was determined by each participant in response to a question asking her to assess the overall severity of her symptoms. In addition, a "PMS score" was calculated for each woman. This score was equal to the sum of each respondent's rating of severity for each in the list of 10 symptoms plus the "other" symptoms category, as contained in the questionnaire. A score of one was assigned to each symptom rated mild, a score of two was assigned to each moderate symptom, and a score of three was assigned to each severe symptom. The range of possible PMS scores, therefore, was 0 (no premenstrual symptoms) to 33 (11 severe symptoms).

Results

Prevalence of Premenstrual Symptoms and Types of Beverages Consumed

Six-hundred-and-sixteen (73 percent) of the 841 respondents reported experiencing at least one premenstrual symptom, and 603 (72 percent) reported consuming at least one cup of a caffeine-containing beverage each day. For all types of beverages consumed, a total of 7,048 cups of fluid were reported to be consumed each day: 39 percent water, 20 percent caffeine-containing soda, 12 percent fruit juice, 11 percent milk, 6 percent caffeine-containing coffee, 6 percent caffeine-free soda, 3 percent hot chocolate, 2 percent each caffeine-containing tea and herbal tea, and less than 1 percent each decaffeinated coffee and grain beverages: other beverages accounted for less than 1 percent of the total cups consumed. Seventy-one percent of the total volume of caffeine-containing beverage consumed was soda, 21 percent was coffee, and 8 percent was tea.

Consumption of Caffeine-containing Beverages

The overall prevalence odds ratio for daily consumption of one to 10 caffeine-containing beverages among women who reported experiencing at least one premenstrual symptom compared with women who reported no premenstrual symptoms was 1.5 (90% confidence interval = 1.1, 2.0). This effect was restricted primarily to women whose PMS scores equaled 16 through 31 (the highest score observed).

For the 399 women with PMS scores between 1 and 15 (median score = 9), the prevalence odds ratio for daily consumption of any caffeine-containing beverages (one to ten cups per day) was 1.3 (90% CI = 0.9, 1.7). This point estimate remained unchanged when controlled for daily total fluid consumption. The estimates for one to five cups per day, and for six to 10 cups per day, were similar (1.2 and 1.1, respectively) when daily total fluid consumption was controlled (Table 1).

Among women with PMS scores from 1 to 15, 61 percent rated the overall severity of their PMS symptoms "mild" while only 2 percent rated their symptoms "severe."

Table 2 shows the prevalence odds ratios of premenstrual syndrome for consumption of caffeine-containing beverages among the 217 women whose PMS scores equaled 16 through 31 (median score = 19). For these women, the overall prevalence odds ratio (one to 10 cups of caffeine-containing beverages per day relative to no cups) was 2.0 (90% CI = 1.4, 2.9). A steadily increasing prevalence odds ratio was observed for increasing amounts of daily consumption of caffeine-containing beverages, ranging from 1.3 for one cup per day to 7.0 for eight to 10 cups per day. All of the estimated prevalence odds ratios, except the estimate for one cup per day, were slightly reduced when daily total fluid consumption was controlled (Table 2).

The p-value of the test for trend between premenstrual syndrome and daily cups of caffeine-containing beverages

TABLE 1—Prevalence Odds Ratios of Premenstrual Syndrome According to Daily Consumption of Caffeine-containing Beverage Consumption among the 399 Women Whose PMS Scores Equaled 1 through 15

	Daily Consumption of Caffeine-containing Beverages (Cups)		
Control for Total Fluid	0 POR*	1–5 POR*	6–10 POR*
No	1.0	1.2 (0.9, 1.7)	1.6 (0.8, 3.1)
Yes	1.0	1.2 (0.9, 1.7)	1.1 (0.6, 2.4)
Number of Exposed Women**	194	396	34

*Prevalence Odds Ratio, Relative to 0 Cups per Day (90% Confidence Interval).
**Includes Cases and Controls.

TABLE 2—Prevalence Odds Ratios of Premenstrual Syndrome According to Daily Consumption of Caffeine-containing Beverages with and without Controlling for Daily Consumption of Total Fluid Intake among the 217 Women Whose PMS Scores Equaled 16 through 31

	Daily Consumption of Caffeine-containing Beverages (Cups)					
Control for Total Fluid	0 POR*	1 POR*	2–4 POR*	5 POR*	6–7 POR*	8–10 POR*
No	1.0	1.3	2.0	2.5	5.0	7.0
Yes	1.0	1.3	1.8	2.1	3.3	6.5
Number of Exposed Women**	121	85	172	22	27	15

*Prevalence Odds Ratio, Relative to 0 Cups per Day.
**Includes Cases and Controls.

consumed was <0.001. The slope of the logistic curve relating premenstrual syndrome and daily consumption of caffeine-containing beverages (without control for total fluid intake) was 0.22 (standard error = 0.047). The slope of the logistic curve relating premenstrual syndrome and caffeine-containing beverage consumption, controlling for daily total fluid intake, was reduced to 0.18 (standard error = 0.046); thus, each additional daily cup of caffeine-containing beverage was associated with a 20 percent increase in the prevalence of premenstrual syndrome (e · 18 = 1.2).

Among women with PMS scores from 16 to 31, 12 percent rated the overall severity of her symptoms "mild" while 18 percent rated her symptoms "severe."

Types of Caffeine-containing Beverages

Table 3 shows the prevalence odds ratios of premenstrual syndrome among women with PMS scores equal to 16 through 31 who consumed either caffeine-containing soda or caffeine-containing tea or coffee on a daily basis. The data show that both caffeine-containing soda and caffeine-containing tea/coffee were associated with an increase in the prevalence of premenstrual symptoms, and that the effect was higher, per amount of exposure, for consumers of tea/coffee than for soda consumers over the range of consumption studied (0 to 8 cups of soda, and 0 to 3 cups of tea/coffee). There were too few data on which to base effect estimates for larger amounts of consumption.

TABLE 3—Prevalence Odds Ratios of Premenstrual Syndrome According to Daily Consumption of Caffeine-containing Soda or Tea/Coffee among Women Whose PMS Scores Equaled 16 through 31

Daily Consumption of Caffeine-containing Soda (Cups)**		
0 POR*	1–5 POR*	6–8 POR*
1.0	1.3 (0.9, 2.0)	7.0 (2.1, 22.9)
Daily Consumption of Caffeine-containing Tea/Coffee (Cups)***		
0 POR*	1 POR*	2–3 POR*
1.0	1.4 (0.6, 3.3)	5.3 (2.3, 12.2)

*Prevalence Odds Ratio, Relative to 0 Cups per Day (90% Confidence Interval).
**Based on the 176 cases who consumed caffeine-containing soda on a daily basis but who did not consume caffeine-containing tea or coffee, and on 121 cases who consumed no caffeine-containing beverages.
***Based on the 41 cases who consumed caffeine-containing tea or coffee on a daily basis but who did not consume caffeine-containing soda, and on 121 cases who consumed no caffeine-containing beverages.

Total Fluid Intake

The overall prevalence odds ratio for daily consumption of six to 19 cups of fluid, relative to daily consumption of two to five cups, among women who reported experiencing at least one premenstrual symptom compared with women who reported no symptoms was 1.7 (90% CI = 1.0, 3.0). The prevalence odds ratios for women with PMS scores between 1 and 15 (less severe symptoms) were 1.2 (0.6, 2.4), 1.7 (0.9, 3.3), and 2.1 (1.0, 4.5) for 6–7 cups per day, 8 to 10 cups per day, and 11–19 cups per day, respectively.

Table 4 shows the prevalence odds ratios of premenstrual syndrome for total fluid intake, with and without control for daily consumption of caffeine-containing beverages among the 217 women with PMS scores between 16 and 31 (the same subset of women referred to in Table 2). For these women, the overall prevalence odds ratio (six to 19 cups of fluid consumed per day relative to two to five cups consumed per day) was 1.7 (90% CI = 1.1, 2.7). A steadily increasing prevalence odds ratio was observed for increasing amounts of daily total fluid intake, although the size of the increase was small from six or seven to 11–12 cups of fluid per day. The prevalence odds ratio estimates were reduced somewhat when daily consumption of caffeine-containing beverages was controlled. In both sets of estimates, the only large effects observed were among women consuming between 13 and 19 cups of fluid each day.

The p-values associated with the overall trend between premenstrual syndrome and daily total fluid intake were <0.001 and 0.01 without and with control for daily consumption of caffeine-containing beverages, respectively. The corresponding slopes of the logistic curves were 0.091 (standard error = 0.027) and 0.065 (standard error = 0.026).

Discussion

We found a strong association between consumption of caffeine-containing beverages and the prevalence of premenstrual symptoms which was not explained by daily total fluid consumption. The effects for women with PMS scores between 16 and 31 (women with more severe symptoms) were highly dose-dependent, and were present both among women whose source of caffeine was soda and to a stronger extent (on a per cup basis) among women whose source of caffeine was tea and/or coffee. The relation between daily total fluid consumption and premenstrual symptoms, both with and without control for daily consumption of caffeine-

TABLE 4—Prevalence Odds Ratios of Premenstrual Syndrome According to Daily Total Fluid Consumption with and without Controlling for Daily Consumption of Caffeine-containing Beverages among the 217 Women Whose PMS Scores Equaled 16 through 31

	Daily Total Fluid Consumption (Cups)				
Control for Caffeine-containing Beverages	2–5 POR*	6–7 POR*	8–10 POR*	11–12 POR*	13–19 POR*
No	1.0	1.3	1.5	1.7	3.4
Yes	1.0	1.2	1.3	1.5	2.3
Number of Exposed Women**	59	102	144	63	66

*Prevalence Odds Ratio, Relative to 2–5 Cups per Day.
**Includes Cases and Controls.

containing beverages, was more moderate (over the ranges of values studied) than was the relation for daily consumption of caffeine-containing beverages. The relation between premenstrual symptoms and daily total fluid intake appeared to be dose-dependent, at least when the highest level of intake (13–19 cups per day) was taken into account. The fact that the estimated effects for daily total fluid intake were similar for women with PMS scores between one and 15 (mild symptoms), and for women with PMS scores between 16 and 31 (more severe symptoms), however, seems difficult to reconcile with a causal interpretation of the observed effects.

One possible source of error in this study warrants discussion. We used a self-administered questionnaire to collect information about the presence and severity of premenstrual symptoms. Although a definition of premenstrual syndrome was included in the questionnaire, it may be that some women confused premenstrual with menstrual symptoms or otherwise misinterpreted the meaning of "premenstrual symptoms," and responded accordingly. To evaluate this possibility, 51 study participants volunteered to keep a three-month daily record of symptoms, and to record the first and last days of their menstrual periods. (These women also maintained a daily record of certain dietary factors, exercise history, and stressful life events which may have affected daily symptoms such as anxiety or depression.) These women were told that the purpose of the daily diary was to obtain more detailed information about symptoms throughout the menstrual cycle than was possible using a one-time mail questionnaire. Forty-three (84 percent) of the volunteers completed at least two months of the daily diary. Of these women, 32 (74 percent) completed all three months. One of us (AMR), blinded with respect to the volunteers' responses on the mail questionnaire, rated the severity of premenstrual symptoms (no symptoms, mild, or moderate/severe) for each of the 43 subjects who completed at least two months of the diary, and then compared these ratings to the PMS scores as determined from each woman's mail questionnaire. Overall, 60 percent (26/43) of the ratings and PMS scores matched; that is, the blind assessment of severity, which was based on the actual symptoms recorded in the daily diaries, corresponded to the assessment of PMS severity as summarized in the PMS score (0 = no PMS, 1–15 = mild, 16 or higher = moderate/severe). The majority of the misclassification (11 of 17 misclassified cases) occurred among women who were rated as not having premenstrual syndrome but whose PMS scores equaled one to 15 (mild). Considerably less misclassification occurred between other categories of PMS severity.

The effects of such misclassification, if generalizable to the other study participants, would be to reduce somewhat the size of the observed associations between consumption of caffeine-containing beverages or total fluid intake and PMS among women with PMS scores of 16 or higher, and to substantially reduce the size of the observed associations between consumption of caffeine-containing beverages or total fluid intake and PMS among women with scores of one to 15. The lack of a strong, observed association between consumption of caffeine-containing beverages and PMS among women with PMS scores of one to 15 may be attributable in large part to the inclusion of women who do not regularly experience premenstrual symptoms into this PMS group.

Neither observation bias nor selection bias would seem to be a potentially large source of error in the present study because data from both women who experience premenstrual symptoms and women who do not experience these symptoms were collected in the same manner using identical mail questionnaires; the questionnaire contained an equal number of questions about menstrual health as it contained about premenstrual health; the study hypothesis was not disclosed to the study participants nor is the hypothesis generally well-known or accepted to be true among the population studied; and none of the 51 study participants who volunteered to keep daily records of symptoms (with whom there was bi-weekly personal contact) indicated that she suspected the specific nature of the study hypotheses.

The observed associations between premenstrual symptoms and daily consumption of caffeine-containing beverages theoretically could reflect some uncontrolled third factor but any such factor would have to be present among both caffeine-containing soda consumers and among caffeine-containing tea/coffee consumers, would have to vary jointly with the amounts of such beverages consumed, and would have to be prevalent among young women in both the United States and the People's Republic of China.[5] Neither alcohol use, cigarette use, exercise habits, oral contraceptive use, nor a diet high in beef or refined sugar products, all putative causes/preventives of premenstrual syndrome, satisfies such criteria. A mechanism involving the depressive action of adenosine on central neurons has been suggested by Phillis for how caffeine might cause premenstrual syndrome.[23]

Theoretically, a definitive evaluation of the effects, if any, of caffeine-containing beverages on premenstrual syndrome would involve a randomized trial. The inherent difficulties in conducting such a trial, however, would be considerable.

It seems worth considering that the etiological factors of premenstrual syndrome may operate anew during each menstrual cycle, making the latent period between exposure to caffeine-containing beverages and the onset of premenstrual syndrome short. If true, any beneficial effects which arise from the elimination of caffeine from the diet should be apparent within a relatively few menstrual cycles. For this reason, and because there are few, if any, known beneficial effects associated with caffeine-containing beverage consumption, women who wish to reduce the severity of their premenstrual symptoms may want to consider eliminating caffeine-containing beverages from their diets and then evaluating any changes in the severity of their symptoms after several months. Such a decision, determined on the basis of each woman's personal history with premenstrual symptoms, should be made with full knowledge that there may be no benefits derived from such abstinence for a particular woman. This is the case, however, for many public health recommendations whose bases reside in population-based (epidemiologic) research.

APPENDIX

Subset of the Questionnaire: Question About Beverage Intake

23. About how many *cups* of each of the following beverages do you drink during a typical *day?* (One "cup" is equal to about eight ounces, or one measuring cupful.)

Water:________________

Fruit juice________________

Milk________________

Caffeine-free soft drink________________

Caffeine-containing soft drink________________

Hot chocolate________________

Decaffeinated coffee________________

Caffeine-containing coffee________________

Herbal tea (non-caffeine-containing tea)________________

Caffeine-containing tea________________

Milk shake, ice cream soda________________

Other beverages (note that alcoholic drinks are listed in question 24)________

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CPHA to Sponsor November 29 Symposium on Proposals for ICD–10

With the implementation of the 10th revision of the *International Classification of Diseases* (ICD–10) scheduled for the first half of this decade, health care providers, policy makers, and others will be able to classify and collect more comprehensive patient data than ever before. ICD–10 represents a complete restructuring of ICD–9–CM, the classification system currently used in the United States to code patient diagnoses in the inpatient hospital setting. Designers of ICD–10 are structuring the new taxonomy so that health care professionals will be able to capture data that will facilitate "cradle to grave" health care analyses.

To address the changes in coding technology that will result with ICD–10, the Commission on Professional and Hospital Activities (CPHA) of Ann Arbor, Michigan is sponsoring a national symposium in Chicago, November 29, 1990. Attendees at the symposium will evaluate the work that has been done thus far on chapter 21 of ICD–10, which deals in large part with ancillary factors, such as social environment or occupational hazards which influence the patient's health status and necessitate contact with health services, both as an inpatient and in the ambulatory setting. Participants from national organizations, speakers who will address specific issues, and a reactor panel all will be featured in the symposium. Health care professionals interested in learning more about the conference or in participating on the reactor panel should contact Marge Zernott, Director of Classification Development at CPHA, tel: (313) 930-7990.

Walking and Serum Cholesterol in Adults

LARRY A. TUCKER, PHD, AND GLENN M. FRIEDMAN, MD

Abstract: We measured the association between walking for exercise and the ratio of total cholesterol/HDL cholesterol in 3,621 adults. After controlling for age, gender, income, body fat, alcohol use, exercise other than walking, and cigarette smoking, adults in the high, moderate, and low duration walking categories were compared to those in the no walking-no exercise category. The relative risk for total/HDL ratios of 5.0 or more were .46 (95% CI = .27, .80), .48 (95% CI = .30, .76), and 1.11 (95% CI = .81, 1.53) respectively. (*Am J Public Health* 1990; 80:1111–1113.)

Introduction

Although hypercholesterolemia is a key risk factor of cardiovascular disease,[1] its determinants, including physiologic, demographic and lifestyle factors, are less well established. Mounting evidence indicates that physical activity fosters favorable levels of serum cholesterol,[2–6] but findings have been inconsistent,[7–13] and many of the investigations have failed to control for the effects of alcohol use, body fat, tobacco use and other factors.

Despite the present-day enthusiasm for walking as a means of promoting health and fitness,[14,15] only two investigations have been conducted to determine the relation between walking and serum cholesterol,[10,16] and they have shown mixed results. Hence, the present study was conducted to assess the relation between walking for exercise and serum cholesterol, particularly the total cholesterol/high density lipoprotein cholesterol (HDL) ratio in 3,621 adult men and women. A secondary purpose was to ascertain the extent to which physiologic, demographic, and lifestyle factors confound the association.

Methods

Subjects

Subjects were employees of over 25 different companies that chose to participate in an ongoing health promotion/disease prevention screening program. Approximately 62 percent of the subjects were female, 85 percent were White, 69 percent were married, and 66 percent reported some college education. Mean age of the sample was 40.0 years (SD = 11.1) and the median gross family income was between $25,000–$30,000.

Approximately 14 percent of the employees elected not to participate in all of the health evaluations leaving a sample of 3,621 adults for the present investigation.

Instrumentation and Procedures

Registered nurses employed by Health Advancement Services, Inc., collected all of the data. Each subject was examined individually and privately for 60 minutes after participating in an orientation and completing an informed consent form. A structured questionnaire was used to collect demographic and lifestyle information. Weekly duration and frequency of walking for exercise was assessed as recommended by Stephens, *et al*,[17] but walking intensity was not measured. Total time spent exercising each week was also measured. A step test, the Kasch 3-minute Pulse Recovery Test,[18] assessed cardiovascular fitness. In the present study, as reported walking duration increased, physical fitness increased showing strong linear (Mantel-Haenszel: $\chi^2 = 48.0$, df = 1, $p = 0.0001$) and general associations ($\chi^2 = 87.5$, df = 18, $p = 0.0001$). Indirect validation of the total exercise time variable was demonstrated previously.[19]

Approximately 10 cc of blood was drawn from each subject and analyzed using the enzymatic method to determine serum cholesterol levels.[20] A Harpenden skinfold caliper was employed to assess subcutaneous fat at three body sites on each subject: for males, thigh, chest, abdomen; for females, iliac crest, triceps, thigh. The sum of the skinfold measurement along with age and gender were used to calculate the total body fat percentage of each subject.[21]

Data Analysis

Subjects were grouped into four categories according to their self-reported, weekly duration of walking for exercise and total exercise time:

- *None*: subjects reporting no weekly walking for exercise nor any regular exercise;
- *Low*: ½–2 hours of weekly walking for exercise;
- *Moderate*: 2½–4 hours of weekly exercise walking;
- *High*: 4½ hrs per week or more of exercise walking.

The total serum cholesterol/HDL ratio was calculated because the total/HDL ratio has greater heart disease predictive utility than the others used individually.[1] A total/HDL ratio of 5.0 or greater was used to signify high risk according to current recommendations.[22]

The relation between weekly walking duration and elevated total cholesterol/HDL ratios was measured by the odds ratio.[23] Subjects who reported no weekly walking for exercise nor any regular physical exercise were used as the reference group. Mantel-Haenszel summary risk estimates[24,25] were employed to control for the potential confounders: age, gender, income, body fat, alcohol use, cigarette smoking, and exercise other than walking. Analysis of covariance (ANCOVA) was used to determine mean total cholesterol, HDL-C and total/HDL cholesterol differences among the walking groups with the potential confounders controlled.

Results

Table 1 shows the relations between the control variables, walking duration, and the total cholesterol/HDL ratio. High walking duration was more common in those who were male, leaner, poorer, nonsmokers or light smokers, not heavy drinkers, those who performed little exercise other than walking, and those in their 20s or above 50 years of age. Those with elevated total/HDL ratios tended to be male,

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Address reprint requests to Larry A. Tucker, PhD, Director of Health Promotion, 273 S.F.H., Brigham Young University, Provo, UT 84602. Dr. Friedman is with Health Advancement Services, Inc. This paper, submitted to the Journal July 3, 1989, was revised and accepted for publication January 31, 1990.

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TABLE 1—Walking Duration and the Total/HDL-C Ratio According to the Control Variables

Control Variables	col%	Hours of Weekly Exercise Walking (row %)				Total/HDL ratio ≥5
		none[a]	½–2	2½–4	4½+	
Total Group	100	54.4	26.8	11.2	7.5	27.5
Age (years)						
19–29	19.4	49.8	29.8	11.9	8.5	17.0
30–39	32.2	53.7	30.0	8.8	7.6	25.4
40–49	26.8	60.0	22.4	12.2	5.4	30.2
50+	21.6	51.7	25.6	13.4	9.3	36.6
Gender						
male	38.1	53.4	25.3	11.0	10.3	44.8
female	61.9	55.1	27.8	11.4	5.8	14.2
Income (k)						
not reported	7.6	56.7	24.0	10.6	8.7	32.7
<15	9.7	50.4	22.6	14.6	12.3	23.7
16–24	17.5	58.2	24.5	10.3	7.1	26.1
25–44	36.8	55.7	26.2	11.1	7.1	28.0
45+	28.4	51.4	31.4	10.9	6.3	26.4
Body Fat						
lean	8.9	42.5	32.8	12.6	12.2	13.6
moderate	57.2	50.0	30.1	12.3	7.7	24.6
obese	33.9	59.5	23.4	9.8	7.3	39.0
Alcohol Use						
none/light	70.0	52.8	28.8	11.4	7.1	19.8
moderate	26.3	56.8	23.0	10.9	9.3	45.1
heavy	3.7	73.0	15.1	6.4	5.6	49.2
Exercise[*]						
none	83.8	80.2	8.4	6.8	4.6	27.4
½–2 hrs.	10.3	0.0	67.8	15.2	17.0	21.4
2–3½ hrs.	3.6	0.0	70.6	29.4	0.0	25.2
> 3½ hrs.	2.3	0.0	85.1	14.9	0.0	20.8
Smoking						
non/ex	80.2	52.8	28.8	11.4	7.0	25.0
1–20 daily	14.9	56.6	21.6	11.6	10.2	35.4
21 + daily	5.0	69.3	17.1	8.0	5.7	46.3

[*] "Exercise" included all exercise reported except walking.

[a] "None" (reference group), under the "Hours of Weekly Exercise Walking" heading included adults who did not walk for exercise or perform any other type of regular exercise.

older, fatter, smokers, drinkers, non-exercisers, and not poor.

Table 2 displays the prevalence of elevated total cholesterol/HDL ratios among the adults in the reference and walking categories, and estimated risk for each of the groups before and after adjustment for the potential confounders.

Table 3 shows the mean cholesterol differences among the four walking categories with the potential confounders controlled statistically (ANCOVA).

Discussion

The present findings indicate that adults who walk for exercise 2½–4 hours or more each week tend to have less than one-half the prevalence of elevated total cholesterol/HDL ratios (total/HDL ratio ≥ 5.0) as those who do not walk or exercise regularly.

There are a number of explanations as to why walking duration and the total/HDL ratios appear to be strongly related. High total cholesterol/HDL ratios may reflect problems that lead to decreased exercise-walking. Because subjects with elevated total/HDL ratios tend to be more obese and smoke more than their counterparts[1,26] and because obese adults and those who smoke tend to walk less than non-obese and non-smokers (findings of present study), adults with elevated ratios may choose not to walk as much as others. Elevated total cholesterol/HDL ratios and exercise-walking each may be caused by other common factors.

TABLE 2—Estimated Risk of Elevated Total/HDL Ratio by Weekly Walking Duration

Weekly Walking Duration	Variable Controlled	Elevated Total/HDL Ratio[a]			
		N	%	RR_{mh}	95% CI
None (n = 1,970)	none	583	29.6	1.00	—
½–2 hrs (n = 972)	none	233	24.0	0.75	0.63,0.89
	age, gender, ses, fat, alcohol, smoking, other exercise[b]			1.11	0.81,1.53
2½–4 hrs (n = 406)	none	90	22.2	0.68	0.53,0.87
	age, gender, ses, fat, alcohol, smoking, other exercise[b]			0.48	0.30,0.76
4½ hrs + (n = 273)	none	73	26.7	0.87	0.65,1.15
	age, gender, ses, fat, alcohol, smoking, other exercise[b]			0.46	0.27,0.80

NOTE: Subjects who reported no regular exercise walking or other exercise were used as the reference group.

[a] Elevated Total/HDL ratios were defined as those ratios ≥ 5.0.

[b] Other exercise included all exercise reported other than walking.

TABLE 3—Adjusted Mean Differences in Cholesterol among the Walking Groups

	Weekly Walking Duration							
	None		Low		Moderate		High	
Variable	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Total/HDL Ratio	4.81	1.6	4.70	1.4	4.49	1.3	4.53	1.6
Total-C (mmol/L)	5.34	1.1	5.28	1.0	5.19	1.1	5.19	1.1
HDL-C (mmol/L)	1.18	0.3	1.20	0.3	1.22	0.3	1.22	0.3

Means were adjusted for differences in age, gender, income, body fat, alcohol use, exercise other than walking, and cigarette smoking.

With the moderate and high duration walking groups combined and the covariates controlled, the following mean differences resulted (mmol/L):

Total/HDL ratio: None ($M = 4.86$) Moderate + High ($M = 4.53$), difference (.33); 95% confidence limits of the difference (.18, .46), $p < .05$

Total-C: None ($M = 5.33$) Moderate + High ($M = 5.14$), difference (0.19); 95% confidence limits of the difference (0.08, 0.29), $p < .05$

HDL-C: None ($M = 1.17$) Moderate + High ($M = 1.21$), difference (0.04); 95% confidence limits of the difference (0.01, 0.06), $p < .05$

Other potential confounders, particularly diet, could account for the inverse association between walking duration and elevated total/HDL ratios since research suggests that exercisers may consume different diets than non-exercisers,[27] and diet may be related to serum cholesterol levels.[1]

Finally, desirable total/HDL ratios may, in fact, result from moderate to high levels of exercise walking. Numerous studies confirm a connection between other types of aerobic exercise, besides walking, and favorable levels of serum cholesterol.[2–6]

Because subjects in the present study had relatively high socioeconomic status and education levels, generalization to poorer, less educated groups will necessitate further research.

Given the correlational design of this study, cause-and-effect conclusions are not warranted. However, if a causal relation is assumed, then at least 2½ to 4 hours of exercise walking per week should be practiced for protection against elevated total/HDL ratios. In the present study, ½ to 2 hours of weekly walking for exercise was not associated with decreased risk of high total/HDL ratios.

ACKNOWLEDGMENTS

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Public
Health Briefs

Abstinence from Smoking and Expired-Air Carbon Monoxide Levels: Lactose Intolerance as a Possible Source of Error

Ann D. McNeill, PhD, Lesley A. Owen, PhD, Michael Belcher, RMN,
Gay Sutherland, MPhil, and Simon Fleming, MSc

Abstract: We investigated a possible source of contamination of expired-air carbon monoxide (CO) readings on CO monitors from raised expired-air hydrogen (H_2) levels, namely lactose intolerance, the norm in certain ethnic groups. A significant correlation between expired-air CO and H_2 readings was observed in four non-smoking lactose maldigesters. (*Am J Public Health* 1990; 80:1114–1115.)

Introduction

Expired-air carbon monoxide (CO) measurement is a simple and cheap method of validating non-smoking status in ex-smokers.[1] While falling short of the specificity and sensitivity of cotinine measures, it is the preferred method in a wide range of field settings.[2] Its application takes on particular value in the light of the increasing use of nicotine replacement strategies in smoking cessation. It is important that this test be valid if the success rates of smoking cessation interventions are to be correctly estimated and individuals spared needless embarrassment should they be suspected of not telling the truth about their smoking status.

We investigated a possible source of false positives in expired-air CO readings.

Method and Results

Bedfont EC50 and EC50 micro smokerlyzer portable CO monitors are the most popular means of measuring expired-air CO in smoking clinics in the United Kingdom[3] and are also used in the United States. The non-smoking/smoking cut-off CO value most commonly used is 10 ppm.[2] A non-smoking member of our staff was surprised to find a level of 36 ppm expired-air CO after routinely blowing into such a monitor as a demonstration of its use. This raised level was obtained with other Bedfont CO monitors and was not attributable to raised ambient CO.

Expired-air CO levels after 20 seconds breath-holding are in approximate equilibrium with the concentration of carboxyhaemoglobin in the blood.[1] However, in this case, carboxyhaemoglobin levels were normal (1.0 percent) indicating that expired-air CO levels were not raised and that the CO monitor must have been picking up another gas.

The instruction manual for these monitors indicated that they are specially constructed to be insensitive to interferences from hydrogen (H_2), alcohol, and other organic species.[4] As alcohol was eliminated as a possible source of interference, H_2 levels were investigated. The technical specification for the CO monitors indicates that 20 ppm H_2 would give less than a 4 ppm reading.[4]

Raised H_2 levels in humans can arise from several causes, such as lactose intolerance, excessive bacteria in the small intestine and variations in transit time through the small intestine.[5] Recent studies also indicate that breath H_2 excretion increases between three and seven hours after normal subjects have ingested flours derived from whole or refined wheat, oats, corn, potatoes or baked beans.[6]

Monitoring the subject's CO levels throughout the day revealed a strong diurnal pattern which was possibly related to food intake (breath hydrogen tends to be higher after waking).[6] Further investigation revealed that this subject was lactose intolerant. A Bedfont EC60 H_2 monitor which measures the H_2 content of expired air, confirmed that H_2 levels were raised and mirrored the apparent CO levels throughout a typical working day (see Figure 1). This suggested that the CO reading was being contaminated by raised H_2 levels.

The relation between expired-air CO and H_2 levels was further investigated using lactose tolerance tests.[7] A significant correlation between the expired-air CO and H_2 readings was observed in this subject and in an additional three

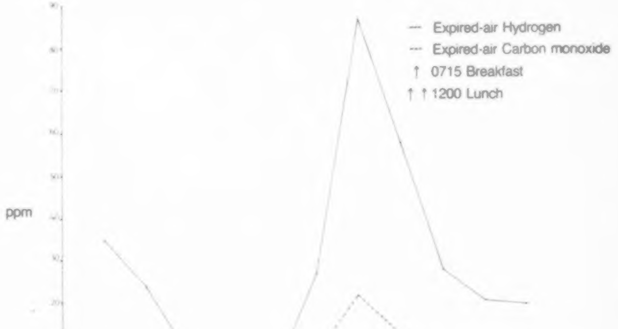

FIGURE 1—Expired-Air Carbon Monoxide and Hydrogen Levels of Subject as a Function of Time of Day

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Address reprint requests to Ann D. McNeill, PhD, Addiction Research Unit, Institute of Psychiatry, 101 Denmark Hill, London, SE5 8AF, UK. Co-authors Owen, Belcher and Sutherland are also with the Addiction Research Unit; Dr. Fleming is with the Department of Chemical Pathology, St. George's Hospital Medical School, London. This paper, submitted to the Journal August 7, 1989, was revised and accepted for publication December 14, 1989.

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non-smokers who were known to be lactose maldigesters ($r = 0.99$, $r = 0.95$, $r = 0.97$, and $r = 0.75$; $n = 6$ for each subject; range for CO values = 3 to 34 ppm; range for H_2 levels = 2 to 183 ppm). A regression analysis was carried out using the CO and H_2 values to estimate the level of hydrogen at which a CO reading of 10 ppm would be obtained. A linear trend was fitted across time and yielded a non-significant time-subject interaction and between-subject effect. An expired-air H_2 level of 38.91 ppm would be sufficient to register 10 ppm on a CO monitor (2.5 percent of individuals with levels of 42.07 would register less than 10 ppm, 2.5 percent of individuals with levels of 35.75 would register above 10 ppm). In lactose maldigesters a CO level of 10 ppm would therefore be achieved by consuming, for example, 350 ml or approximately two small glasses of milk.

Discussion

Despite the methodological limitations imposed by the small sample size, the strong patterns observed indicate that there may be cases where individuals classified as smokers on the basis of CO validation have a condition which results in raised expired-air H_2 levels. The proportion of the population who would fall into this category is unknown. As stated earlier, one of the causes of raised H_2 levels is lactose intolerance, which is thought to have a strong hereditary component: a recent estimate of primary lactose intolerance in the UK is given as 6 percent.[8] However, it can also be acquired following diseases which damage the small intestinal villi, for example, giardiasis, coeliac disease, tropical sprue, chronic alcoholism, rotavirus infections in children, and cholera.[7,8] Furthermore, not all lactose intolerant individuals are aware of their condition[9] and some can tolerate moderate quantities of milk, possibly as a result of acquired tolerance to the symptoms.[7]

The likelihood of middle-class Caucasians having raised H_2 levels due to lactose intolerance which could contaminate CO levels may be minimal. However, in certain ethnic groups the prevalence of lactose intolerance is much higher, for example, Jews,[9] American Blacks (among whom the figure is 75 percent), and certain African and Oriental races where it approaches 100 percent.[8] It would be counter-productive if a greater proportion of minority groups, when attempting smoking cessation, were to be wrongly labeled. Among such groups, CO validation may need to be supplemented by cotinine, or if nicotine replacement is being used, by carboxyhaemoglobin analysis. It would not be sufficient when performing the expired-air CO test to ask when the subject last consumed a dairy product as there are considerable inter and intraindividual differences in rates of absorption.[6]

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Abstracts Sought for Nursing Research Conference

Abstracts are invited for the 10th annual research conference, entitled "Building Knowledge for Nursing: The Impact of the Human Immunodeficiency Virus," co-sponsored by the University of South Florida College of Nursing, and Delta Beta Chapter of Sigma Theta Tau, and scheduled to be held February 21–22, 1991 in Tampa, Florida. The deadline for submission of abstracts is September 30.

For further information, contact: Loretto Ramella Lopez, RN, EdD, Chair, Research Committee, University of South Florida, College of Nursing, Tampa, FL 33612-4799. Telephone: (813) 974-2191.

A Population-Based Descriptive Study of Housefire Deaths in North Carolina

MICHAEL J. PATETTA, MA, AND THOMAS B. COLE, MD, MPH

Abstract: We report a population-based study of housefire deaths in North Carolina in 1985 using data obtained from fire investigators and the North Carolina medical examiner system. The crude death rate was 3.2 per 100,000 population; age-specific death rates were highest for ages 75–84 years. Death rates for Whites were one-third as high as death rates for other races. Of those decedents tested for alcohol, 56 percent had blood alcohol levels ≥ 22 mmol/L. Most fatal fires were caused by heating units or cigarettes. (*Am J Public Health* 1990; 80:1116–1117.)

Introduction

Three-fourths of the 5,000 fire and burn deaths that occur annually in the United States are caused by housefires.[1,2] In 1984, the US housefire death rate[1] was 1.9 per 100,000 population. However, in the South the rate[1] was 2.5 per 100,000, and in the Southeast in recent years rates have been in the range of 3.05–5.14 per 100,000.[2]

Studies of housefire mortality for the Southeast have found that most deaths occur in heating-related fires, whereas smoking-related fires are responsible for most of the deaths in other parts of the country.[3] There is some evidence that the higher death rate for the Southeast may be attributable to a lower prevalence of smoke detectors and a greater use of portable heating equipment compared with other regions.[4,5]

To describe the epidemiology of housefire deaths in a Southeastern state, we conducted a statewide, population-based study of housefire deaths in North Carolina.

Methods

Records of all housefire deaths in North Carolina in 1985 were obtained from the Office of the Chief Medical Examiner. State law mandates reporting of all fatal injuries to a medical examiner. County medical examiners complete a report (which includes toxicologic information, reports of death scene visits and interviews with witnesses, autopsy records, and other relevant data) for each investigated death for review by a forensic pathologist.

Information about the causes of the housefires was requested from the local fire marshalls or county sheriffs, and responses were received for 70 percent of housefire deaths. The causes of the housefires were documented in Medical Examiner Reports or State Bureau of Investigation Reports for an additional 22 percent of deaths.

Rates and proportions were calculated from pooled data. Housefire death rates are expressed per 100,000 population, but these rates are approximate because some decedents were not North Carolina residents and information was not obtained for North Carolina residents who died out of state.

Results

In 1985, 159 housefires resulted in 200 deaths, accounting for 75 percent of all North Carolina deaths from fire and burns. All but three decedents were North Carolina residents. The crude death rate from housefires was 3.2 per 100,000 population. Death rates were highest (8.8/100,000) for persons ages 75–84 years (Table 1) and for persons other than White (7.1) (Table 2).

Of 157 persons who died at the scene of the fire and were tested for carboxyhemoglobin, 131 (83 percent) were reported by a medical examiner to have died of carbon monoxide poisoning and 26 from burns. Of the 26 not tested, seven (27 percent) were reported to have died of carbon monoxide poisoning and 19 from burns.

Of 160 decedents ≥ 15 years of age, 56 percent of the 130 tested for alcohol had blood alcohol levels ≥ 22 mmol/L (legally impaired under North Carolina driving laws). Of those tested, 85 percent who died in cooking-related housefires, 60 percent who died in smoking-related housefires, and 39 percent who died in heating-related housefires had blood alcohol levels ≥ 22 mmol/L.

Most of the victims (59 percent) died when single-family houses burned, although 76 percent of the North Carolina population lived in single-family houses according to the 1980 census. Although only 9 percent of the North Carolina population lived in mobile homes in 1980, 19 percent died in mobile home fires. Smoke detector information was provided for 72 fatal housefires. Of the 109 deaths in these housefires, 94 percent occurred in dwellings without smoke detectors.

More deaths resulted from housefires caused by heating units (33 percent) than from any other cause (Table 3). Of the 60 heating-related housefire deaths, 20 percent were associated with the use of flammable liquids and 25 percent with the ignition of furniture or furnishings. Woodstoves caused the fires that resulted in 37 percent of heating-related deaths, and kerosene heaters were responsible for an additional 20 percent.

TABLE 1—Age-specific Housefire Death Rates,* North Carolina, 1985

Age Group (years)	Number of Deaths	Death Rate
0–4	23	5.5
5–14	17	1.9
15–24	20	1.8
25–34	12	1.1
35–44	20	2.4
45–54	22	3.5
55–64	27	4.6
65–74	35	8.1
75–84	19	8.8
≥85	5	8.1
Total	200	3.2

*Death rates per 100,000 population are approximate because all instate deaths were counted regardless of the state of residence.

Address reprint requests to Thomas B. Cole, MD, MPH, Injury Control Section, North Carolina Department of Environment, Health, and Natural Resources, P.O. Box 27687, Raleigh NC 27611-7687. (He was with the Division of Field Services, Epidemiology Program Office, CDC, Atlanta.) Mr. Patetta is also with the Injury Control Section. This paper, submitted to the Journal August 17, 1989, was revised and accepted for publication January 23, 1990.

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TABLE 2—Race/Sex-Specific Housefire Death Rates,* North Carolina, 1985

Race/Sex Group	Number of Deaths	Death Rates
White Males	65	2.8
White Females	34	1.4
Other** Males	54	7.1
Other Females	47	5.7
Total	200	3.2

*Death rates per 100,000 population are approximate because all instate deaths were counted regardless of the state of residence.

**With the exception of one American Indian male, all deceased persons of other races were Black. Census data for 1985 do not provide population estimates for Blacks and American Indians.

TABLE 3—Housefire Deaths by Cause* of Fire, North Carolina, 1985

Cause of Fire	Number (%) of Deaths
Heating	60 (33)
Smoking	47 (26)
Cooking	16 (9)
Electrical	15 (8)
Arson	10 (6)
Open Flame	9 (5)
Children Playing	9 (5)
Natural	1 (1)
Undetermined	16 (8)
Total**	183 (101)

*Causes are assigned according to the hierarchy used by the National Fire Data Center of the Federal Emergency Management Agency, so that the number of deaths in each sucessive cause is exclusive of all previously listed causes. For 17 deaths, cause of fire information was not provided by fire investigators.

**Total is > 100% due to rounding.

The second most common cause of housefire deaths was smoking (26 percent). Of the 47 smoking-related housefire deaths, 89 percent occurred in fires caused by the ignition of furniture.

Discussion

Only 16 persons who died in 1985 as result of housefires in North Carolina left the scene of the fire alive. Therefore efforts to improve the emergency treatment and transport of persons injured in housefires could prevent at most 8 percent of housefire deaths. To prevent housefire deaths, fires must be prevented or escaped.

Assuming that the proportion of the North Carolina population living in mobile homes did not change from 1980 to 1985, mobile home dwellers are 2.7 times as likely to die in housefires as persons who live in single-family detached homes. A similar risk was found in New Mexico.[6]

We estimate that the lethal[7-10] combination of alcohol and cigarettes resulted in at least one-fourth of the deaths reported in this study. The proportion of fatally injured persons tested who were impaired with alcohol was greater for housefires (56 percent) than that for any other cause of unintentional injury in North Carolina. The use of fire-safe cigarettes[11] may be the most effective way to prevent deaths associated with drinking and smoking.[2,6]

Escape from housefires is facilitated by early warning, which can be provided by smoke detectors.[8,12] The risk of death from housefire is estimated to be 2.5 times greater for persons who live in homes without smoke detectors.[13] Unfortunately, persons who are very young, very old, or very drunk may not be able to respond to an alarm.[11,13-15] From our data we estimate that these groups accounted for over half of the deaths.

Our study indicates that the risk of housefire death is likely to be multifactorial, with ignition source, type of dwelling, and behavior each playing important roles.

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Estimating the Full Cost of Workplace Injuries

Michael T. French, PhD

Abstract: While many studies estimate medical costs and lost wages from workplace injuries, few have estimated pain and suffering costs. This study develops a wage-risk model for railroad workers and estimates the total cost of on-the-job injuries. On average, the total cost of an on-the-job injury to a railroad worker in 1980 was between $19,500 and $22,500. These estimates are substantially higher than the sum of medical costs plus lost wages. (*Am J Public Health* 1990; 80:1118–1119.)

Introduction

Workplace injuries impose a variety of costs on injured workers. The most frequently estimated costs are expenditures for medical services and wages lost from missed work. But injured workers also bear other costs such as pain and suffering.

Economists use several methods to estimate the cost of workplace injuries. The conventional approach is the cost-of-illness method.[1–5] In simple form, the cost-of-illness method estimates the cost of injury as the sum of medical-related expenditures plus lost wages. The strengths of the cost-of-illness method are that it uses accessible data on medical expenditures and personal earnings, and it is easy to apply. The main weakness of the cost-of-illness method is that it neglects important components of the total cost of workplace injury.

Recently, economists have developed methods to estimate the cost of workplace injuries based on individuals' willingness to pay to reduce injury risks. If workers perceive and understand the consequences of on-the-job injuries, the willingness-to-pay method captures the full range of costs to individuals.

The willingness-to-pay method is not without limitations, however. If workers underestimate their true exposure to workplace risks and if real or perceived barriers inhibit workers from reacting to risk changes (e.g., long-term labor contracts), then injury cost estimates will be downward biased. In addition, since willingness to pay is influenced by workers' income, *ability* to pay is inseparable from *willingness* to pay. Nevertheless, the willingness-to-pay method represents a major stride toward estimating the full cost of workplace injuries.

Several researchers have used the willingness-to-pay method to estimate the cost of premature death,[6–10] but few have studied nonfatal injuries.[11,12] This paper develops a willingness-to-pay model and estimates the full cost to workers of on-the-job injuries in the railroad industry.

Methods

Generally, workers' wages depend on demographic characteristics of the workers (e.g., age, education, marital status, and region of residence), characteristics of the job (e.g., blue collar, white collar, skilled, or unskilled), and the riskiness of the job. Job risk can be measured as the number of injuries per million worker-hours. Using multivariate regression analysis applied to data from a sample of workers, researchers can estimate the importance of each variable in determining workers' wages. In particular, the analysis shows how much workers must be paid to get them to accept additional workplace risk, other things held equal. The amount workers must be paid to accept additional risk is called the "compensating wage differential."

The compensating wage differential is at the heart of the willingness-to-pay method for estimating total cost imposed on workers by on-the-job injuries. For example, suppose the regression analysis shows that the compensating wage differential is $0.50, calculated on weekly wages. In other words, on average, workers in the sample are willing to accept a $0.50 reduction in weekly wages ($26 per year) for a one-unit decrease in the workplace injury rate. If the annual probability of workplace injury is 0.004, then four in 1,000 workers are likely to be injured on the job each year. Since on average each individual is willing to accept a $26 reduction in annual wages to reduce the probability of injury to 0.003, or three in 1,000, then the workers' total willingness to pay to avoid one injury is ($26 per worker)(1,000 exposed workers) = $26,000.

This analysis uses wage, demographic, and occupational data from the March 1980 Current Population Survey[13] plus on-the-job injury data from the Federal Railroad Administration[14] and the Association of American Railroads[15] to estimate railroad workers' willingness to pay to reduce workplace risk. The sample includes railroad workers living in the 48 continental states who reported wages, demographic characteristics, personal characteristics, and occupation by Census Bureau categories. Discarding records with missing data and records for workers who had more than one employer in 1980 left a sample of 460 railroad workers. Table 1 lists all variables used in the regression model along with sample means and standard deviations.

TABLE 1—Variable Means and Standard Deviations (N = 460)

Variables	Mean	Standard Deivation
Weekly wage	437.375	133.542
Male	0.935	0.247
Caucasian	0.928	0.258
Age	39.863	12.831
Included in company pension plan	0.876	0.330
Included in company health plan	0.961	0.194
Head of household	0.878	0.327
Residence in northeastern US	0.163	0.370
Residence in southern US	0.320	0.467
Residence in north central US	0.243	0.430
Married	0.748	0.435
Highest grade attended	12.920	2.420
Occupation		
Professional and technical	0.028	0.166
Managers and administrators	0.141	0.348
Sales and clerical	0.122	0.327
Craftsmen	0.352	0.478
Operators	0.235	0.424
Laborers	0.020	0.139
Injuries per million worker-hours	32.974	23.241

Address reprint requests to Michael T. French, PhD, Center for Economics Research, Research Triangle Institute, 3040 Cornwallis Road, Research Triangle Park, NC 27709. This paper, submitted to the Journal October 30, 1989, was revised and accepted for publication March 2, 1990.

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Results

I estimated several different wage-risk regression models. Table 2 gives a complete set of parameter estimates and regression statistics from the linear and log-linear specifications. Most coefficients have plausible signs and are statistically different from zero at the 0.05 or higher level of significance.

On average, the estimated annual compensating wage differential for railroad workers is 0.0021 (the regression coefficient for the risk variable from the log-linear specification) multiplied by $437 (the average weekly wage for workers in the sample), multiplied by 49 (the average number of weeks worked per year), which yields a value of $45. To compute a total willingness-to-pay estimate, I multiply the compensating differential estimate ($45) by the average number of workers affected by the injury risk [500 workers = (1 million worker-hours/2,000 hours)], yielding an estimate of $22,500 per injury. Using the linear specification, I estimate railroad workers' total willingness to pay to reduce the risk of workplace injury at $19,500 per injury. All other estimates from different specifications of the regression model fall in the range of $19,500 to $22,500.

TABLE 2—Estimation Results for Linear and Log-Linear Wage-Risk Equations

	Parameter Estimates (N = 460)*	
Independent Variable	Log-linear Equation (R^2 = 0.32)	Linear Equation (R^2 = 0.31)
Constant	4.8940	4.9504
	(0.1371)	(59.5639)
Married	0.0027	−4.2994
	(0.0311)	(13.5067)
Head of household	0.0739	36.7836
	(0.0416)	(18.0759)
Male	0.0653	17.9962
	(0.0603)	(26.2137)
Caucasian	0.0321	23.3190
	(0.0491)	(21.3247)
Included in company pension plan	0.1210	34.7646
	(0.0388)	(16.8389)
Included in company health plan	0.1337	18.0227
	(0.0671)	(29.1577)
Residence in northeastern US	−0.0034	3.6966
	(0.0387)	(16.8197)
Residence in north central US	0.0592	22.3930
	(0.0323)	(14.0148)
Residence in southern US	−0.0295	−12.7819
	(0.0350)	(15.2006)
Age	0.0025	1.2286
	(0.0011)	(0.4786)
Highest grade attended	0.0187	9.4581
	(0.0059)	(2.5827)
Professional and technical	0.4783	169.4618
	(0.1066)	(46.3366)
Managers and administrators	0.5523	225.6686
	(0.0675)	(29.3057)
Sales and Clerical	0.3213	94.4426
	(0.0812)	(35.2666)
Craftsmen	0.3467	118.2067
	(0.0588)	(25.5369)
Operators	0.2958	104.5947
	(0.0487)	(21.1727)
Laborers	0.1074	33.4127
	(0.0975)	(42.3456)
Injuries per million worker-hours	0.0021	0.7964
	(0.0009)	(0.3967)

*standard errors in parentheses

Discussion

In 1980, the average on-the-job injury in the railroad industry resulted in 16 days away from work. If workers received no compensation for lost wages and if injured workers spent all 16 days in the hospital—which are clearly overstatements—then the cost-of-illness method estimates the average cost of an injury to an injured worker at only $5,318 ($245 per day for hospital care and $437 per week in lost wages).

Willingness-to-pay estimates from the wage-risk model presented in this paper indicate that, on average, railroad industry employees faced an expected cost of between $19,500 and $22,500 per injury. These estimates are considerably larger than the sum of medical costs and lost wages because they include the cost of pain and suffering. Comparing cost-of-illness and willingness-to-pay estimates suggests that the *avoided* cost of pain and suffering is a substantial component of the total value of workplace safety for railroad workers and that conventional cost-of-illness estimates grossly underestimate the full cost of these injuries.

ACKNOWLEDGMENT

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Perforating Eye Injury in Allegheny County, Pennsylvania

DEBORAH LANDEN, MD, MPH, DAVID BAKER, MD, MPH, RONALD LAPORTE, PHD, AND RICHARD A. THOFT, MD

Abstract: From 1980 through 1986, acute perforating eye injury (ICD codes 871.0–871.9) was diagnosed in 345 residents of Allegheny County, Pennsylvania. The mean incidence rate was 3.49 per 100,000 person years. There was no significant change in incidence over the seven-year period. The largest number of injuries occurred among individuals working with tools, of which 47 percent were occupational. Males had a 6.5-fold risk of injury relative to females. Blacks had a risk of 2.2 times that of Whites, mainly due to an excess of assaultive injuries. Individuals who had had recent ocular surgery accounted for 4.6 percent of cases overall, and for 31.6 percent of cases in those over age 60. (*Am J Public Health* 1990; 80:1120–1122.)

Introduction

Eye injuries are a major cause of visual impairment. They are the leading cause of monocular blindness in the United States, and account for 7 percent of bilateral blindness in the 20–64 year age group.[4]

While several population-based studies of eye injuries have been published, they include predominantly minor injuries which are unlikely to lead to loss of vision.[1-6] Perforating eye injuries threaten vision and can be expected to result in hospitalization at the time of occurrence. Two previous hospital record studies of eye injuries in defined populations have included a report of the incidence of perforating eye injuries. Karlson and Klein reported an incidence of ocular lacerations of two per 100,000 in Dane County, Wisconsin in 1979.[3] Tielsh, *et al*, reported an incidence of open wounds of the eyeball of 3.81/100,000 in Maryland during the years 1979 through 1986.[6]

Only one previous study has reported both incidence rates and risk factors for perforating eye injuries. Blomdahl and Norrell[7] studied perforating eye injuries in the population of Stockholm through review of hospital records and interviews of patients identified as cases. They reported an incidence of 60.6 per million population among men and 11.8 per million among women during the period 1974–79. The highest incidence was in the 10–19 years age group. The most frequent circumstance of injury was paid work, followed by play or sport, domestic work, assault, and traffic accidents. Metal and glass fragments were the most common perforating objects, followed by nails and knives.

We describe the epidemiology of perforating eye injury in Allegheny County, Pennsylvania during the years 1980 through 1986.

Methods

Inpatient records were reviewed at the 24 hospitals in Allegheny County and surrounding areas which serve Allegheny County residents. Cases were defined as any Allegheny County resident discharged from one of the listed hospitals with a primary or secondary diagnosis of perforating eye injury (ICD codes 871.0–871.9).

Demographic information, as well as address at the time of admission, the type of injury incurred, and surgical procedure performed, if any, were abstracted from the records. A brief description of the circumstances surrounding each injury was compiled; information was available for 97 percent of cases. E-codes from the record were not used. Cases included were only those with a first time admission for that diagnosis. Cases seen at more than one hospital for the incident injury (e.g. a community and a tertiary care hospital) were counted only once.

Two hospitals refused to allow review of their medical records. However, they provided a count of cases meeting our ICD code criteria, although no information as to whether the case was an Allegheny County resident. From this information, we estimate that we missed three cases at most from these hospitals.

Population data for Allegheny County were obtained from the Pennsylvania State Data Center. For 1980, these data were from the national census. For other years, estimates developed by the State Data Center by sampling were employed. Rates for each year were age standardized against the 1980 Allegheny County population; 95 percent confidence limits for all rates were calculated.[8] Taylor series confidence intervals were constructed for all measures of relative risk.[9]

In order to assess the effect of socioeconomic status on risk of injury, census tract of residence was determined from the Cole's directory for a random sample of 150 cases, stratified by race.[10] Mean income was determined for census tract of residence from 1980 census data.[11]

Results

Three hundred forty-five Allegheny County residents sustained perforating eye injuries during the years 1980 through 1986, for a mean incidence rate of 3.49 per 100,000

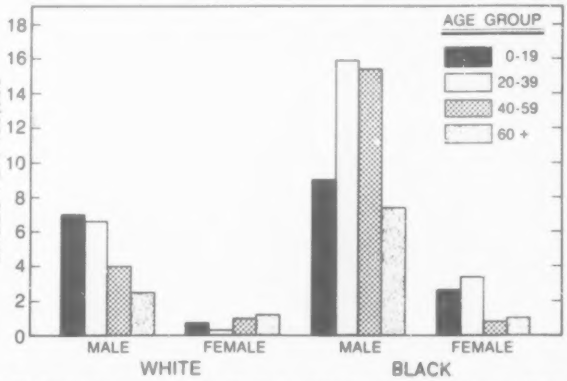

FIGURE 1—Age- and Sex-Specific Rates of Perforating Eye Injury by Race, Allegheny County, PA 1980–86

From the Department of Epidemiology, Graduate School of Public Health, University of Pittsburgh (Landen, Baker, LaPorte); and Department of Ophthalmology, Eye and Ear Institute, University of Pittsburgh, Pennsylvania (Thoft). Address reprint requests to Deborah Landen, MD, MPH, Division of Safety Research, National Institute for Occupational Safety and Health, 944 Chestnut Ridge Road, Morgantown, WV 26505. This paper, submitted to the Journal October 10, 1989, was revised and accepted for publication January 31, 1990.

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person years. Annual incidence rates were stable over the seven-year period. Mean incidence rates for the seven-year period, specific for age, race and sex, are shown in Figure 1.

There was only a slight difference in incidence between Whites and Blacks for those under age 20. For those over age 20, the incidence in Whites was reduced, while for Blacks it increased, reaching a peak among those ages 20–59, and then declined in those over age 60 (Table 1). Assaultive injuries were the major contributor to the increased incidence in Blacks (Table 2). When assaultive injuries were excluded, there was no difference in rates between the racial groups for those ages 20–39, although an excess of injuries was still seen among Blacks over age 40.

Injuries to males occurred at a rate 6.6 times that of females, with excess risk for males in all age groups (Table 1) and all categories of cause (Table 2). When occupational injuries were excluded, the relative risk for males compared to females remained elevated at 5.4.

Circumstances of injury are presented in Table 2. The most frequent circumstance of injury, accounting for 23 percent of cases, was work with tools; 47 percent of injuries in this category were occupational. Most injuries occurred when bits of metal, wood, or other material broke off and were propelled into the eye, or when a hammered nail recoiled. However, the tool itself was the cause of injury in four of 11 cases occurring during car repair. In contrast, the tool itself caused injury in only one out of 68 cases not associated with car repair. Five out of 36 occupational injuries occurred when a particle was propelled by another person's work or by machinery in the workplace.

Of recreational activity and childplay injuries, 23 percent were due to BBs.

Minor trauma (e.g. "bumped eye") to individuals with a history of opthalmologic surgery was responsible for 3.2 percent of injuries. We separately analyzed all injuries which had occurred within three months of ocular surgery, whether due to minor or more significant trauma. These injuries accounted for 4.6 percent of cases overall. Among those over age 60, 31.6 percent of all injuries had occurred within three months of surgery. In contrast only 1.3 percent of injuries in those under age 60 were associated with recent ocular surgery.

Falls were the circumstance of injury for 6.7 percent of cases. Seven of 23 fall injuries occurred in nonnormal eyes (postsurgical or underlying condition such as Terrien's marginal degeneration).

Seven and a half percent of injuries were sustained in motor vehicle accidents. The hospital record provided little information about the part of the vehicle actually causing the injury.

TABLE 1—Relative Risk of Perforating Eye Injury, Black:White and Male:Female, by Age, Allegheny County, PA 1980–86

Age	RR B/W	(95% CI)	RR M/F	(95% CI)
0–19	1.30	(.82, 2.07)	7.71	(6.68, 8.74)
20–39	2.77	(1.89, 4.07)	11.18	(10, 12.36)
40–59	2.93	(1.64, 5.23)	4.88	(3.21, 6.55)
60+	2.17	(1.09, 3.25)	2.53	(1.25, 3.81)
Total (Age-Adjusted)	2.18	(1.53, 3.09)	6.55	(5.98, 7.12)

Ten percent required enucleation. Thirteen of these 34 cases were due to assault.

Individuals living in census tracts with mean annual incomes below $10,000 had an incidence rate of 7.4 per 100,000 person years, compared to a rate of 3.2 per 100,000 person years for those living in census tracts with mean incomes above $10,000. The relative risk for low income vs high income census tract residence was 2.3, with a 95 percent confidence interval of 1.47, 3.56.

Discussion

Comparison with the Swedish study of perforating eye injuries (6.6 per 100,000 for men and 1.2 for women) shows that our sex-specific incidence rates of 5.7 and 1.5, respectively are quite similar; they also showed no consistent trend over time.

Young males experienced the highest risk of injury in both studies. We found an increased risk among Blacks. However, this excess risk may represent lower socioeconomic status of Blacks. Individuals living in low income census tracts had a higher risk of injury; mean income for Blacks in Allegheny County is substantially lower than that for Whites.[11]

Among individuals working with tools, over half the injuries occurred in nonoccupational settings. In the occupational setting, injuries can be prevented through required eye protection or separation of persons without eye protection from areas in which they might sustain injury. The many injuries which occurred during home and car maintenance and repair are preventable if people become aware of the risk of eye injury in this setting and wear protection. Efforts to increase public awareness of this hazard are indicated.

Many product-associated injuries can be prevented either by modification or elimination of the product. The continuing rate of visual loss due to BB gun injuries is an example.

TABLE 2—Relative Risk of Perforating Eye Injury by Circumstance, Black:White and Male:Female, Allegheny County, PA 1980–86

Circumstance	Cases (%)	RR B/W	(95% CI)	RR M/F	(95% CI)
Work with tools	78 (22.6)	1.03	(.45, 2.34)	38.80	(3.1, 517.2)
Recreation/Childplay	69 (20.0)	1.35	(.59, 3.08)	13.35	(2.54, 71.69)
Assault	47 (13.6)	9.41	(3.11, 28.5)	6.42	(1.35, 30.24)
Motor Vehicle Accident	26 (7.5)	1.03	(.25, 4.26)	12.84	(.90, 194.9)
Falls	23 (6.7)	1.96	(.70, 10.32)	1.39	(.29, 6.55)
Post Surgical-Minor Trauma	11 (3.2)	2.37	(.33, 16.99)	3.52	(.28, 45.55)
Other*	79 (22.9)	1.93	(.82, 4.52)	4.95	(1.72, 14.25)
Unknown	12 (3.5)	1.40	(.20, 9.74)	1.40	(.20, 9.74)

*explosions, walking into objects, recoiling objects, animal bites and scratches, accidental gunshot wounds.

A surprisingly large number of injuries occurred among those with recent ocular surgery. This should be investigated further, as such cases were responsible for over a third of injuries to those over age 60.

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Fatal and Severe Injury: Scooter and Moped Crashes in California, 1985

MICHAEL SALATKA, MPH, SHAKEH ARZEMANIAN, MPH, JESS F. KRAUS, MPH, PHD,
AND CRAIG L. ANDERSON, DHSC, MPH

Abstract: Fatal and severe injury crashes for scooters and mopeds in California for 1985 were compared with those for motorcycles during the same year. Scooters had more than twice the injury crash rate of mopeds but one-half the rate of motorcycles. Age of injured drivers and crash patterns for scooters, mopeds, and motorcycles varied significantly. (*Am J Public Health* 1990; 80:1122–1124.)

Introduction

In the past 15 years, the use of mopeds and scooters in the United States has increased markedly[1]; by 1987, there were an estimated 360,000 scooters and 170,000 mopeds in use.[2]

Some information is available on injuries from moped crashes[3–13] but virtually none on injuries involving scooters. Unlike motorcycles, mopeds and most scooters are not designed for traveling long distances or at high speeds and are not legal for use on freeways in California and most other states. We examine fatal and severe injury crashes for operators of mopeds and scooters in California during 1985 and compare their crash rates and other characteristics to those of motorcycles.

Methods

Definition, Criteria, and Crash Data Source

A moped is a two-wheeled, motor-powered bicycle with an automatic transmission and 12- to 17-inch wheels; almost all have an engine displacement of 49 cc or less. As single rider vehicles, they are not designed to carry passengers. Models made before 1981 may have pedals for propulsion.[14–18]

A scooter is a two-wheeled, motor-powered vehicle with an enclosed engine, automatic transmission, 10- to 12-inch wheels, and engine displacement ranging from 50 cc to 250 cc. Scooters have a floorboard, no pedals for propulsion, and may have a passenger seat.[14,18,19]

In California, the operator of a scooter must pass the same licensing tests as motorcycle operators; scooters must be registered annually. A moped may be operated with any class of driver's license. Annual registration is required for scooters and mopeds without pedals, including mopeds manufactured since 1981.[20]

This research was limited to moped and scooter crashes on public roads in California during 1985 that resulted in either a fatal or severe injury to the driver of the vehicle. General methods of crash injury data collection are contained in an earlier report.[21] Severe injuries are those resulting in a distorted body member or a laceration from which blood flows freely. Off-road injury crashes were excluded.

Fatal and severe injury crashes were identified from the computerized Statewide Integrated Traffic Records System maintained by the California Highway Patrol.

Crash Data and Exclusions

Of the 322 crashes of two- and three-wheel motor vehicles that were not street-legal motorcycles, the following were excluded: 81 off-road motorcycles, 33 all-terrain vehicles, 18 other vehicles that could not be identified.

Information on the vehicle identification number, vehicle license plate number, make, model, and model year was abstracted from the original crash report.

The 1985 California Department of Motor Vehicles registration file provided information on 156,114 two- or three-wheeled vehicles after all motorcycles were excluded. Off-road or all-terrain vehicles (16,649) and scooters or mopeds with registrations expiring before 1985 or first sold in 1986 (41,572) were also excluded. The number of scooters and mopeds at risk of crashing during 1985 was 97,893 in the State of California.

The date on which the vehicle was first sold or registered in California and the registration expiration date were used to

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From the Department of Epidemiology, UCLA School of Public Health. Address reprint requests to Jess F. Kraus, PhD, Professor, Department of Epidemiology, School of Public Health, University of California, 10833 Le Conte Avenue, Los Angeles, CA 90024-1772. This paper, submitted to the Journal August 28, 1989, was revised and accepted for publication March 7, 1990.

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TABLE 1—Fatal and Severe Injury Scooter, Moped, and Motorcycle Crash Rates per 10,000 Registered Vehicle-Years, California, 1985

Vehicle	Crashes	Registered Vehicle Years	Crash Rate	Standard Error*
Scooters	131	34,174	38	3
Mopeds	59	37,286	16	2
Total**	190	75,907	25	2
Motorcycles***	1,832	246,562	74	2

*Calculated as (crashes)$^{1/2}$/(registered vehicle-years).

**The total includes 4,447 registered vehicle-years for scooters and mopeds that could not be classified as to type.

***Motorcycle data from reference 21.

estimate potential use-months during 1985. The scooters and mopeds registered in 1985 represented 75,907 potential use-years.

The 17-character Vehicle Identification Number was used to distinguish scooters and mopeds from other two- and three-wheel motor-powered vehicles.

Data on motorcycle crashes from a previous report[21] are included for comparison. The chi-square statistic was used to test for homogeneity between results for scooters, mopeds, and motorcycles.

Results

Almost 69 percent of the 190 total crashes involved scooters and 31 percent involved mopeds. Scooters had more than twice the crash rate of mopeds, although both rates were considerably less than the rate for motorcycles (Table 1).

The percentages of fatal injury crashes were 8.5 for mopeds, 11.4 for scooters, and 19.6 for motorcycles. The odds of motorcycle fatal injuries compared to those of mopeds and scooters was 1.9 (95% confidence interval = 1.2, 2.9).

Over 59 percent of injured scooter operators and almost 41 percent of injured moped operators were under 20 years of age (Table 2), compared with less than 20 percent of injured motorcycle operators. Nearly 5 percent of the scooter crashes and about 7 percent of the moped crashes involved an operator less than 15 years of age.

In the fatal and severe scooter and moped crashes, 79 percent of the operators were male. Over 98 percent of injured motorcycle operators were male.

Broadside (either vehicle) collisions accounted for 41 percent of the scooter crashes and 51 percent of the moped crashes (Table 3). With the data available, we could not distinguish which vehicle was struck in broadside collisions.

Scooters and mopeds have considerably higher proportions of broadside and rear-end collisions than do motorcycles. Motorcycles, however, overturned* and hit objects more often than did scooters and mopeds.

Scooters and mopeds crashed most frequently in spring and fall, and the highest proportion of crashes occurred on Monday and Friday. More than 60 percent of all scooter and moped crashes occurred between noon and 8:00 pm, and fewer than 10 percent occurred between 2:00 am and 10:00 am. Motorcycles crashed most frequently in the summer and on Saturdays and Sundays. Fifty-one percent of motorcycle crashes occurred between noon and 8 pm.

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*Defined by the California Highway Patrol as falling to the ground without a preceding collision.

TABLE 2—Number and Cumulative Percentage of Fatal and Severe Injury Scooter and Moped Crashes According to Age of Operator, California, 1985

	Scooters			Mopeds			Motorcycles		
Age (years)	Number	Percent	Cumulative Percent	Number	Percent	Cumulative Percent	Number	Percent	Cumulative Percent
<15	6	4.6	4.6	4	6.8	6.8	6	0.3	0.3
15–19	71	54.6	59.2	20	33.9	40.7	352	19.4	19.7
20–24	19	14.6	73.8	16	27.1	67.8	674	37.0	56.7
25–29	10	7.7	81.5	3	5.1	72.9	362	19.9	76.6
30+	24	18.5	100	16	27.1	100	425	23.4	100.0
All Ages	130*	100.0		59	100.0		1,819*	100.0	

*Age was unknown for one scooter operator and 13 motorcycle operators.

TABLE 3—Fatal and Severe Injury Scooter, Moped, and Motorcycle Crashes by Collision Type, California, 1985

	Scooters		Mopeds		Motorcycles	
Collision Type	Number	Percent	Number	Percent	Number	Percent
Impact with another vehicle	107	81.7	52	88.1	1191	65.0
Head-on	18	13.7	6	10.2	179	9.8
Broadside	54	41.2	30	50.8	610	33.3
Rear-end	24	18.3	9	15.2	215	11.7
Sideswipe	11	8.4	7	11.9	187	10.2
No other Vehicle	24	18.3	7	11.9	641	35.0
Hit object	13	9.9	2	3.4	363	19.8
Overturn	7	5.3	4	6.8	245	13.4
Other	4	3.0	1	1.7	33	1.8
All Types	131	100.0	59	100.0	1832	100.0

Over 87 percent of fatal and severe scooter and moped crashes occurred in urban areas. About 95 percent of the crashes occurred on streets and roads that are not state highways compared with 79 percent of motorcycle crashes.

Discussion

Scooters have a higher crash rate than mopeds. This could represent different usage patterns or a different crash risk with similar usage.

The higher percentage of severe injury crashes as opposed to fatal crashes, for mopeds and scooters compared with motorcycles, suggests different patterns of use and speed capabilities of these vehicles.

The higher proportion of scooter and moped crashes involving a collision with another motor vehicle may be due to their frequent use in urban areas and their decreased visibility to other motorists due to their smaller size.

Teenagers had the highest number of fatal and severe injury scooter and moped crashes, which is consistent with the observation that these vehicles are used principally by adolescents and young adults.[8,14] Because scooter and moped crashes occur mostly among teenage drivers, countermeasure efforts might be most effective if directed specifically toward this population.

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Call for Abstracts for PREVENTION 91

PREVENTION 91, the eighth annual national disease prevention and health promotion meeting sponsored by the American College of Preventive Medicine and the Association of Teachers of Preventive Medicine as well as numerous co-sponsors, will be held in Baltimore, Maryland March 16–19, 1991. The meeting theme, "Building an Economic Framework," will be the focus of four days of general sessions, concurrent sessions, poster sessions, workshops, and computer demonstrations.

Abstracts are sought for presentations at PREVENTION 91 which are directly linked to the meeting theme or to one of the topics already selected as the focus for the concurrent scientific sessions. Abstracts must be submitted on the standard abstract form, which may be obtained from: Hazel Keimowitz, PREVENTION 91, 1015 15th Street, NW, Suite 403, Washington, DC 20005. Tel: (202) 789-0006. Abstracts must be postmarked by October 1, 1990 to qualify for this year's consideration.

PREVENTION 91 will present up to six $100 awards to residents/students who submit and present the best abstracts describing their research. Selection criteria include rigorous scientific methodology, clarity, organization, originality, and relevance to the meeting theme.

City Directories as Sources for Survey Work in Low- and Middle-Income Black Communities

EDWARD J. STANEK III, PHD, HARRIS PASTIDES, PHD, WILLIAM A. DARITY, PHD, AND MARY ELKINS, MS

Abstract: Commercial directories and governmental lists of dwelling units in low income urban Black communities in four eastern cities were evaluated for completeness. With rare exceptions, less than 90 percent of dwelling units were included in any one list and no list adequately identified multiple dwelling unit structures. Since household income is likely to be lower among households in such structures, all lists tend to miss the very poor, i.e., those who may be at highest health risk. (*Am J Public Health* 1990; 80:1125–1126.)

Introduction

Community-based surveys are commonly used for needs assessment and program evaluation. The starting point for postal or personal interview surveys is a list of dwelling units (DUs) (or individuals) in the study community. There are usually several possible sources for such lists. An important factor in selecting a list is the degree to which a list covers the actual target population. The list selected is often the list with the largest number of entries.

Knowledge of coverage is important for interpretation of survey results. Certain commercial lists claim to cover, on average, over 95 percent of the DUs.[1] If coverage does not selectively underrepresent groups of individuals, such lists may be adequate. However, low coverage has been reported for DUs in multiple DU structures[1] and for areas that are hard to enumerate.[2] Socioeconomic status (SES) of such areas is likely to be low, and health risks of residents high. Lack of coverage of DUs in such areas may have an important impact on interpretation of results.

To evaluate the potential for bias due to inadequate coverage of low and middle SES communities, we evaluated coverage in lists from four communities: from Columbia, South Carolina, Durham, North Carolina, Hartford, Connecticut, and Springfield, Massachusetts. We discuss the implications of these results for frame construction and subsequent study interpretation.

Methods

Two commercial and two or three governmental lists (voter and property lists) were available in each community. A field list was also constructed by having study personnel canvass the areas on foot using an established protocol.[3] Coverage of each list was evaluated by comparison with a population frame. The population frame included DUs present in the original field list, along with DUs subsequently verified after combining lists.

Study communities were selected in each city using 1980 census data to include at least 300 DUs with a Black adult, low/middle income level, and non-adjacent to areas used in a larger study. Each community was defined on a census map, and boundaries confirmed by physical check. The communities and lists of DUs are given in the Appendix.

Verified computer lists for each source were edited for duplicates. All commercial and governmental lists were then combined to form a single list representing non-field listing sources with one record per DU. Special computer programs were written in SAS to accomplish the matching.[4] Further details concerning individual lists, and list processing are given elsewhere.[5]

Results

The communities in the four cities differed by number of residential structures, percent of structures that contained multiple DUs, and number of DUs. The number of residential structures contained in the final frames are 445, 273, 213, and 1205, in Columbia, Durham, Hartford, and Springfield, respectively. In Columbia and Springfield, a small portion of the residential structures contained more than one DU (0.9 percent and 5.4 percent), while a larger portion of residential structures were multiple DU structures in Durham (39.6 percent) and Hartford (69.5 percent). The total number of DUs identified per community ranged from 1,334 in Springfield to 396 in Durham. The percent of DUs identified as single DU structures ranged from 10.7 percent in Hartford to 84.2 percent in Columbia.

Results of the comparison of each list with the final frame in each community are summarized in Table 1. The original field list identified between 92.0–95.6 percent of the residential structures in all areas except Springfield. In each city (except Springfield) close to 90+ percent of residential structures were identified by at least one other list. However, 10 lists identified less than 80 percent of residential structures.

Coverage of DUs was lower. Two coverage rates for each list are shown in Table 1, where DUs have been grouped by single or multiple DU structure. In order for a DU to be correctly identified, the street number and apartment number/letter in a source must agree with that given in the final population frame. Field listings resulted in more than 80 percent coverage of DUs from single or multiple unit structures. Other lists covered at most 93 percent of single DUs, and 61 percent of multiple DUs.

Overall, DU coverage via the original field list was 95.2 percent (Columbia), 89.9 percent (Durham), 91.7 percent, (Hartford) and 84.7 percent (Springfield). In contrast, the only lists that identified more than 70 percent of the DUs

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From the Division of Public Health, University of Massachusetts, Amherst. Address reprint requests to Edward J. Stanek, III, PhD, Associate Professor/Biostatistics, School of Health Sciences, Division of Public Health, Arnold House, University of Massachusetts, Amherst, MA 01003. This paper, submitted to the Journal July 28, 1989, was revised and accepted for publication February 22, 1990.

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TABLE 1—Percent Identification of Structures and Dwelling Units by City and Source

				DUs Identified by Structure Type			
		Structures		Single		Multiple	
City	Source	n	(%)	n	(%)	n	(%)
Columbia, SC	1st Field List	421	(95)	417	(95)	82	(99)
	Polk	410	(92)	408	(93)	51	(61)
	Tax List	390	(88)	387	(88)	2	(2)
	Tax Map	297	(67)	296	(67)	0	(0)
	Voter	280	(63)	277	(63)	17	(21)
	Cross Reference	248	(56)	245	(56)	2	(2)
Durham, NC	1st Field List	261	(96)	154	(93)	202	(88)
	Polk	245	(90)	144	(87)	139	(60)
	Parcel	245	(90)	149	(90)	10	(4)
	Property List	215	(79)	136	(82)	8	(4)
	Voter	200	(73)	114	(69)	42	(18)
	Cross Reference	175	(64)	108	(66)	19	(8)
Hartford, CT	1st Field List	197	(92)	55	(85)	503	(93)
	Tax Map	195	(92)	60	(92)	10	(2)
	Johnson	183	(86)	48	(74)	46	(9)
	Voter	170	(80)	38	(59)	11	(2)
	Hill-Donnelly	118	(55)	27	(42)	10	(2)
Springfield, MA	1st Field List	1009	(84)	946	(83)	184	(95)
	Voter	990	(82)	925	(81)	3	(2)
	Johnson	866	(72)	826	(73)	11	(6)
	Real Estate	826	(69)	805	(71)	3	(2)
	Hill-Donnelly	564	(47)	536	(47)	3	(2)

correctly were the Polk in Columbia (87.6 percent) and Durham (71.5 percent), and the Tax List in Columbia (74.2 percent). No single list enabled easy identification of multiple DU structures, so as to be useful for targeted list up-dating. The same set of DUs were missed by all lists.[5]

Discussion

The results of this study illustrate the limitations in coverage of existing lists of residential structures and dwelling units in low income urban communities. Low coverage has implications for estimation of community health parameters and interpretation and generalization of study results. As confirmed here, dwelling units not included in a sampling frame are not likely to be missing at random. Missed DUs are likely to be from multiple unit structures or those having no visible identifying number. Such households are likely to differ by income/education from DUs that are listed. If response parameters, including a wide variety of risk factors or exposures, differ by such characteristics, estimates of population parameters not adjusting for differential coverage will be biased. Greater efforts are needed to identify possible variables that differentiate DUs (and household members) included or excluded from sample frames.[6] A healthy skepticism is warranted for characterizations of populations that do not account for such possible biases.

ACKNOWLEDGMENTS

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APPENDIX—Summary of Sources of Commercial and Governmental Lists of Dwelling Units from Four US Cities

City*	Source	List (last update)
Columbia, SC	R.L. Polk & Co.	Polk (87)
	City Publishing Co.	Cross-Reference (87)**
	Election Office#	Voter List (3/88)#
	Tax Office	Tax List (6/86)##
	Tax Office	Tax Map (12/87)##
Durham, NC	R.L. Polk & Co.	Polk (86)
	City Publishing Co.	Cross-Reference (87)**
	Election Office#	Voter List (5/87)#
	Real Estate Office	Parcel List (4/87)
	Real Estate Office	Property Tax Location Registry (1/88)##
Hartford, CT	Hill-Donnelly Co.**	Hill-Donnelly (87)**
	Johnson Publishing**	Johnson Publishing (4/87)**
	Election Office#	Voter List (4/88)#
	Tax Office##	Real Estate Tape (4/88)##
	Tax Office	Assessor's Maps (10/84)##
Springfield, MA	Hill-Donnelly Co.**	Hill-Donnelly (87)**
	Johnson Publishing**	Johnson Publishing (87)**
	Election Commission#	Eligible Voter List (10/87)#
	City Planning##	Real Estate Tape (12/87)##

*Columbia: Census Tract: 110 (Blks 102–107, 110–111, 115, 201–208)
Durham: Census Tract: 3.01.2 (Blks 204–211, 303–306)
Hartford: Census Tract: 5014 (Blks 102–103) & 5018 (Blks 206, 301–303)
Springfield: Census Tract: 8015.02 (Blks all)

**Excludes dwelling units without listed phone numbers

#Includes registered voters only except Springfield which mandates listing all adults age 18 and over.

##Usually does not include number of dwelling units in structure. Lists only structures.

AUTHOR NOTE: Under "Sources," the terms "Tax Office" and "Real Estate Office" refer to those government offices which do assessments for real estate tax purposes.

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Predictors of Vaccination Behavior among Persons Ages 65 Years and Older

PAUL A. STEHR-GREEN, DRPH, MPH, MARY ANN SPRAUER, MD, MPH,
WALTER W. WILLIAMS, MD, MPH, AND KEVIN M. SULLIVAN, MPH, MHA

Abstract: We estimated influenza vaccination coverage of 32 percent among persons 65 years of age and older from the 1987 Behavioral Risk Factor Surveillance System survey. Race other than White, obesity, lack of seatbelt use, and current smoking were associated with decreased likelihood of having been vaccinated. Controlling for these factors, the best predictor of having received influenza vaccination was having had a medical checkup within the last year (Odds Ratio = 2.40, 95% confidence interval = 1.84, 3.14). (*Am J Public Health* 1990; 80:1127–1129.)

Introduction

Influenza annually accounts for substantial morbidity and mortality in the United States, especially in older persons. Influenza resulted in an average of approximately 20,000 excess deaths per year during six influenza epidemics from 1972 to 1981, primarily among persons ages 65 years and over.[1] Influenza vaccine has been shown to be approximately 75 percent effective in reducing deaths from influenza and its complications among high-risk older persons living in institutions.[2] Annual vaccination against influenza is recommended for all persons ≥ 65 years old.[3–5] Yet, despite the continuing morbidity and mortality caused by influenza among older adults, most do not receive annual immunization. The purpose of this study was to identify sociodemographic and health-related attributes that may be associated with influenza vaccine coverage among persons ages 65 years and older.

Methods

Data were analyzed from the 1987 Behavioral Risk Factor Surveillance System (BRFSS), a state-based system which monitors self-reported risk behaviors through monthly telephone surveys of adults.[6] Thirty-one states and the District of Columbia participated in the 1987 BRFSS. A sample of households was selected using a multi-stage cluster sampling design. Individual households within eligible clusters were selected for contact by random-digit dialing.[7] After contacting a household, a respondent was selected randomly from all adults residing in the household.[8] In addition to questions on demographic and lifestyle/behavioral characteristics, one question was asked regarding whether the respondent had received an influenza vaccination within the previous 12 months.

We assessed risk factors (i.e., demographic factors, health "risk-taking" behaviors, and preventive health practices) for differential influenza vaccination coverage levels using weighted data (to compensate for sources of variation in selection probabilities).[9] We calculated estimates of the relative likelihood of having received influenza vaccination among groups with specified characteristics using methods which take into account the complex sampling design.[10] In order to simultaneously control for all demographic and behavioral variables, we also used mutivariate logistic regession to discern whether each of the various demographic and behavioral factors were significantly associated with the likelihood of having received influenza vaccination.

Results

Interviews were completed for 9,851 respondents who were 65 years of age or older; 9,799 (over 99 percent) reported knowing whether or not they had received an influenza vaccination within the previous 12 months. Of these, 32 percent reported having been vaccinated against influenza.[11]

There were no important differences in vaccination coverage among persons 65 years of age or older based on gender, education level, or household income (Table 1). Within employment subgroups, retired persons had the highest vaccination coverage (33 percent vaccinated), followed by persons currently working outside their homes (30 percent), homemakers (27 percent), and those currently unemployed (19 percent); in general, persons employed outside their home were equally as likely to have received the vaccination as those without outside employment. Of the demographic factors, race was most strongly associated with having received influenza vaccination. Whites reported higher vaccination coverage levels (34 percent vaccinated) than did Blacks (22 percent) and Hispanics (16 percent); overall, Whites were significantly more likely than other races to have had influenza vaccination (Relative Risk (RR) = 1.63, 95% CI = 1.38, 1.93). This observation held within all household income strata.

When health "risk-taking" behaviors were examined, persons who were obese (RR = 0.86, 95% CI = 0.76, 0.97), persons who did not regularly use seatbelts (RR = 0.89, 95% CI = 0.80, 0.99), and current smokers (RR = 0.80, 95% CI = 0.68, 0.93) were less likely to have received the influenza vaccine (Table 1). There were no differences in vaccination coverage among older persons who were users of smokeless tobacco products, at risk for acute or chronic alcohol consumption problems (including self-reported drinking and driving), or who had a sedentary lifestyle.

The general characteristics that were most strongly associated with whether persons over 64 years old received an influenza vaccination during the preceding year were those related to knowledge and utilization of other health care services (Table 1). Persons who had had a medical examination within the preceding year were twice as likely to have received influenza vaccination than persons who had not had a checkup within the preceding year. Persons who had ever

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Address reprint requests to Technical Information Services, Center for Prevention Services, Centers For Disease Control, 1600 Clifton Road (MS-E06), Atlanta, GA 30333. Drs. Stehr-Green, Sprauer, and Williams are with the Division of Immunization, Center for Prevention Services at CDC; Mr. Sullivan is with the Division of Nutrition, Center for Chronic Disease Prevention and Health Promotion, CDC. This paper, submitted to the Journal October 30, 1989, was revised and accepted for publication January 18, 1990.

TABLE 1—Relative Risks of Receipt of Influenza Vaccine by Demographic and Behavioral Risk Factors among Persons 65 Years of Age and Older[a]—Behavioral Risk Factor Surveillance System, 1987

Risk Factors	% with Risk Factor	% Vaccinated in Risk Group[b]	Relative Risk[c]	95% CI[d]
Demographic Characteristics				
Male sex	33.6	34.1	1.09	(0.98, 1.22)
White race	89.2	33.8	1.63	(1.38, 1.93)
High school graduate	56.5	32.1	0.98	(0.88, 1.09)
College graduate	12.6	36.3	1.14	(0.98, 1.33)
Low income (< $10,000/yr)	37.5	31.9	0.98	(0.87, 1.10)
Employed outside home	9.1	29.8	0.91	(0.75, 1.11)
Health Risk-taking Behaviors				
Obesity	28.8	29.4	0.86	(0.76, 0.97)
Lack of seatbelt use	36.8	29.6	0.89	(0.80, 0.99)
Current smoking	13.3	26.5	0.80	(0.68, 0.93)
Use of smokeless tobacco	3.6	31.2	0.96	(0.72, 1.28)
Acute drinking problem	2.1	39.3	1.22	(0.83, 1.78)
Chronic drinking problem	2.7	25.4	0.78	(0.56, 1.08)
Drinking and driving	0.2	17.5	0.54	(0.25, 1.15)
Sedentary lifestyle	67.5	31.9	0.96	(0.86, 1.08)
Utilization of Health Care				
Medical exam in last year	80.0	35.9	2.00	(1.73, 2.31)
Ever told had hypertension	45.6	30.0	1.18	(1.06, 1.31)
(Women) Know of mammography	85.6	32.1	1.26	(1.04, 1.53)
Ever had mammogram	44.7	36.7	1.31	(1.14, 1.50)
Mammogram in last year	60.2	40.3	1.27	(1.03, 1.55)

[a] Total sample size was 9,799 persons; however, due to incomplete responses for some questions, the effective sample size for individual analysis varied.

[b] Data for each respondent were weighted by a factor that was inversely related to that respondent's probability of selection in order to compensate for sources of variation in selection probabilities.

[c] Ratio of the proportion of persons with the specified demographic or behavioral characteristic who received an influenza vaccination within the last year to the proportion of persons without the specified characteristic who received the vaccination.

[d] 95% confidence intervals taking into account the complex sample design.

been told by a health professional that they had high blood pressure were somewhat more likely to have received influenza vaccination; however, among these persons there was no increased likelihood of vaccination in those currently taking antihypertensive medications nor among those who reportedly were still hypertensive. Among women, knowledge and utilization of mammography for breast cancer screening was associated with a greater likelihood of receiving influenza vaccination.

When influences of all demographic and behavioral factors were examined simultaneously, those that were previously shown not to be associated were again not correlated with receipt of influenza vaccination. Estimates of relative risk for vaccination associated with race, obesity, lack of seatbelt use, current smoking, or having been diagnosed with hypertension were essentially unchanged. Having had a medical checkup within the last year remained most strongly associated with having received influenza vaccination (Odds Ratio = 2.40, 95% CI = 1.84, 3.15).

Discussion

Our ability to generalize from these estimates is somewhat limited due to non-random selection of states, possible bias due to differences in immunization levels among persons not included in the survey, inability to verify self-reports of immunization status, and the likelihood that there are other factors affecting receipt of influenza vaccination that were not included in these data. However, these results are consistent with previous studies[12, 13] that show utilization of health care services as a strong predictor of whether or not an individual receives influenza vaccination.

Because a recommendation by a health care provider appears to be one of the most important factors influencing a person's decision to be vaccinated,[13] greater attention among providers to implementing recommended immunization practices could help improve influenza vaccine coverage. Annual influenza immunization should be incorporated into their practices; all other vaccines appropriate for adults (pneumococcal, hepatitis B, measles, mumps, and rubella vaccines, and diphtheria and tetanus toxoids) should be offered at every opportunity.[3–5] Barriers (whether sociocultural, physical, or financial) to health care for older persons should be minimized to provide optimal access to preventive, as well as curative, services. In addition, health education efforts to promote healthier lifestyles (e.g., stopping smoking, routinely using seatbelts, and following appropriate exercise programs) should be expanded to include adult immunization as part of overall health maintenance for persons over 64 years of age.

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HIV Seroprevalence and the Acceptance of Voluntary HIV Testing among Newly Incarcerated Male Prison Inmates in Wisconsin

NEIL J. HOXIE, MS, JAMES M. VERGERONT, MD, HOLLY R. FRISBY, DVM, MS, JOHN R. PFISTER, BS, RJURIK GOLUBJATNIKOV, PHD, AND JEFFREY P. DAVIS, MD

Abstract: In 1986–88, voluntary and blinded HIV testing was conducted among Wisconsin male prison entrants. The HIV seroprevalence was 0.30 percent in 1986, 0.53 percent in 1987, and 0.56 percent in 1988. The seroprevalence rates among entrants tested voluntarily did not differ from those tested blindly. Voluntary HIV testing was accepted by 71 percent of male prison entrants in 1988; among entrants reporting intravenous drug use 83 percent consented to voluntary HIV testing. Voluntary HIV testing of entrants appears to be an effective screening strategy in Wisconsin prisons. (*Am J Public Health* 1990; 80:1129–1131.)

Introduction

Because intravenous drug use (IVDU) is associated with both criminal activity and human immunodeficiency virus (HIV) infection, many persons sentenced to correctional facilities are at high risk of HIV infection. While most strategies aimed at minimizing HIV transmission in prisons include provisions for HIV testing, there is a divergence of opinion as to whether testing should be voluntary or mandatory. The World Health Organization has recommended against mandatory testing of prisoners.[1] The American Medical Association, however, has stated that mandatory testing is necessary to protect inmates.[2] Currently, 14 states and the Federal Prison System have mandatory testing policies.[3] In the Wisconsin Correctional System HIV testing is voluntary. We conducted HIV seroprevalence surveys among newly incarcerated male inmates in Wisconsin in 1986, 1987, and 1988 to provide HIV seroprevalence estimates and to evaluate the acceptance of voluntary HIV testing in Wisconsin prisons.

Methods

In Wisconsin, male inmates are admitted to a central intake facility where they receive medical examinations and provide blood specimens for hepatitis B serologic testing; residual sera are retained in a serum bank. While at the intake facility, all inmates view a HIV-related educational videotape, are assessed individually by a nurse for HIV-related risk factors, and are given the opportunity to provide written consent to voluntary HIV testing with post-test counseling.

In 1986, a random sample of banked serum specimens obtained from inmates incarcerated between January 1 and September 29 of that year was selected, all identifying information was removed from these specimens (specimen blinding), and they were then tested for antibody to HIV. In 1987 and 1988, blinded seroprevalence surveys were conducted among inmates incarcerated between January 1 and August 31 of each year who declined voluntary tests. Results of blinded testing were combined with results of voluntary testing performed during the same periods.

Beginning in March 1988, newly admitted inmates were asked to complete voluntary self-administered HIV risk assessment questionnaires as part of the routine intake procedure. Data on inmate age, race, and place of sentencing were obtained from prison records. The blinded study design was approved by the Human Subjects Committee of the University of Wisconsin-Madison.

Specimens were tested at the Wisconsin State Laboratory of Hygiene for the presence of antibody to HIV by enzyme linked immunosorbent assay (Abbott). Repeatedly reactive specimens were tested by Western blot assay. Specimens with at least two viral protein bands (from among p24, gp41, or gp120/gp160) demonstrated by Western blot assay were considered HIV seropositive.

Data were analyzed using *Epi Info* software (Centers for Disease Control, Atlanta, Georgia). The Yates Corrected Chi Square Text (χ^2) was used. Confidence intervals (CI) for odds ratios (OR) were calculated by either the exact or Cornfield method. Mantel-Haenszel weighted odds ratios were used in the age-adjusted analysis.[4]

Results

In 1986, a 48 percent random sample of sera obtained from inmates admitted during the survey period was blindly tested for antibodies to HIV (Table 1). In 1987, 40 percent of

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Address reprint requests to Neil J. Hoxie, MS, HIV Seroprevalence Epidemiologist, AIDS/HIV Program, Wisconsin Division of Health, P.O. Box 309, Madison, WI 53701-0309. Dr. Vergeront is Medical Epidemiologist and Supervisor of the AIDS/HIV Program; Dr. Frisby is also with the AIDS/HIV Program; Dr. Davis is State Epidemiologist and Chief of the Section of Acute and Communicable Disease Epidemiology; all with the Wisconsin Division of Health. Mr. Pfister is Supervisor of the Retrovirus Laboratory; and Dr. Golubjatnikov is Chief of the Immunology Section; both with the Wisconsin State Laboratory of Hygiene. This paper, submitted to the Journal July 24, 1989, was revised and accepted for publication February 14, 1990.

TABLE 1—Results of Voluntary and Blinded HIV Seroprevalence Surveys Conducted among Newly Incarcerated Male Prison Inmates in Wisconsin, 1986–1988

	Year Surveyed		
	1986*	1987	1988
Inmates**	2,087	1,783	1,675
Total sample			
Tested	997	1,689	1,621
HIV+	3	9	9
% HIV+ (95% CI)	0.30 (0, 0.64)	0.53 (0.18, 0.88)	0.56 (0.20, 0.92)
Voluntary sample			
Tested	—	708	1,190
HIV+	—	6	7
% HIV+ (95% CI)	—	0.85 (0.17, 1.53)	0.59 (0.15, 1.03)
Blinded sample			
Tested	997	981	431
HIV+	3	3	2
% HIV+ (95% CI)	0.30 (0, 0.64)	0.31 (0, 0.66)	0.46 (0, 1.10)

*The 1986 survey did not include a voluntary component.

**Adult male inmates newly incarcerated during the study periods.

inmates admitted during the survey period were tested voluntarily; banked specimens with sufficient quantity of sera were available for blinded testing of 92 percent of those declining voluntary HIV testing. In 1988, comparable figures were 71 and 89 percent.

The 1986 HIV seroprevalence does not differ from that observed in 1987 (OR = 1.8, 95% CI = 0.4, 10.2) or in 1988 (OR = 1.8, 95% CI = 0.5, 10.4) (Table 1). The HIV seroprevalence among those tested voluntarily exceeded but did not differ from the HIV seroprevalence among nonvolunteers in 1987 (OR = 2.8, 95% CI = 0.6, 17.3) and 1988 (OR = 1.3, 95% CI = 0.2, 12.6). Combining 1987 and 1988 data, 72 percent of HIV seropositive inmates were detected by voluntary testing.

The rate of voluntary HIV testing has exceeded 60 percent since the third quarter of 1987, reaching 71 percent in 1988. The consent rate for voluntary testing decreased with increasing age ranging from 78 percent of those less than 20 years old to 56 percent among inmates 40 or more years of age (χ^2_{trend}, $p < 0.001$). Rates of voluntary consent were not significantly associated either with race or place of sentencing.

In 1988, 989 (78 percent) of those offered the voluntary risk assessment responded; among respondents 246 (25 percent) reported IVDU. Among respondents reporting IVDU, six (2.4 percent) of 245 tested for antibody to HIV were seropositive compared to none (zero percent) among 741 not reporting IVDU. Among all respondents, 76 percent consented to voluntary HIV testing. Among respondents who reported IVDU, 83 percent (203 of 246) consented to voluntary HIV testing compared to 74 percent (550 of 743) not reporting this behavior (age adjusted OR = 1.8, 95% CI = 1.2, 2.6).

Discussion

Nationally, HIV seroprevalence among prison inmates has ranged from 0–17.4 percent.[5–7] In Wisconsin the rate is relatively low and has remained stable over a three-year period. In our sample, HIV infection was strongly associated with IVDU and the comparably low HIV seroprevalence we observed is a consequence of the relatively low HIV seroprevalence among intravenous drug users sentenced to Wisconsin prisons. Our estimate (2.4 percent) of the HIV seroprevalence among male prison entrants reporting IVDU closely concurs with a 1987 estimate (2.3 percent) of the HIV seroprevalence among intravenous drug users enrolled in drug treatment in Milwaukee.[8]

Voluntary HIV testing in prisons would be ineffective if HIV-infected inmates or those at risk of infection, especially intravenous drug users, systematically self-deferred from voluntary testing. This has occurred in non-prison settings.[9] However, in our study, the rate of voluntary HIV testing among inmates reporting IVDU exceeded that of inmates denying this behavior. Moreover, the results of the 1987 and 1988 surveys indicate that HIV seropositive inmates did not systematically decline voluntary testing. Similar results have been reported among prison inmates in Oregon.[10]

Because of the risk of HIV transmission in prison populations, prevention strategies are needed. We believe that voluntary behavior change, facilitated by effective risk reduction counseling, is the most desirable method of reducing HIV transmission. If voluntary behavior change is a goal, well-accepted voluntary testing may be advantageous to mandatory testing because it enables inmates and counselors to establish a relationship based upon consent, thus promoting the acceptance of risk reduction counseling.

In Wisconsin prisons, voluntary HIV testing and counseling is an effective method of screening inmates for HIV infection. Because the results of this study may not be generalizable to areas of high HIV seroprevalence, each correctional jurisdiction that offers voluntary HIV counseling and testing should evaluate their programs to assure that these services are reaching high-risk inmates.

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Sixth International Conference on Hypertension in Blacks to Meet in Brazil

The Sixth International Conference on Hypertension in Blacks will be held in Salvador, Bahia, Brazil, August 1–5, 1991, and will feature new research papers and state-of-the-art lectures from a pool of 33 countries throughout the world. Conference highlights include:

- Current concepts of ethnicity.
- Blood pressure distributions in racially mixed populations.
- The physiology of stress and hypertension.
- Advances in pharmaceutical agents acting on the renin system.
- Advances in molecular genetics of hypertension.
- Socioeconomic status, ethnicity and hypertension.
- Culture, diet and cardiovascular disease.
- Hypertension: The interplay of genetics and environment.
- The ongoing process of miscegenation.
- Primary health care and hypertension.

The conference will also feature lectures on Brazilian history and culture, since Brazil has the largest population of persons of African ancestry outside of Africa. Topics include:

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- Jorge Amado and modern Brazilian literature.
- Slave rebellions in Brazil.
- History and politics of Brazil today.
- Women in Brazilian society.
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Abstracts must be postmarked by February 1, 1991, and submitted on the standard abstract form, available from: International Society on Hypertension in Blacks, 69 Butler Street, SE, Atlanta, GA 30303. Tel: (404) 589-3810.

New from nchs

Use of Contraception and Family Planning Services in the United States, 1988

WILLIAM D. MOSHER, PHD, AND WILLIAM F. PRATT, PHD

Use of Contraception

The leading contraceptive method overall in both 1982 and 1988 was the pill, but female sterilization was approaching the pill in popularity by 1988: 31 percent of contracepting women were using the pill and 28 percent were using sterilization in 1988.[1] If male and female sterilization are considered together as one method, however, then sterilization was the leading method, used by 39 percent of contracepting couples. Among currently married and formerly married women, female sterilization alone was the leading method. Among never married women, the pill was the leading method by far (Table 1). These findings are based on the National Survey of Family Growth (NSFG), a national sample of women in the United States 15–44 years of age. Personal interviews were conducted in the homes of 8,450 women in 1988, 7,969 women in 1982, and 9,797 women in 1973.

The oral contraceptive pill is the leading nonsurgical method of contraception, and the most effective (except for sterilization) in preventing pregnancy.[2] But it does not prevent the spread of sexually transmitted diseases. The condom is less effective at preventing pregnancy than the pill because it is often not used correctly or consistently,[2] but it is useful for preventing the spread of sexually transmitted diseases. Complete estimates of condom use should therefore include women who rely on their partners to use condoms to prevent sexually transmitted diseases,even if they do not use them to prevent pregnancy. This is a more complex methodological problem which is under study, but not covered in the new reports.

Condom Use

Among never married women using contraception, the proportion who relied on their partner's use of a condom increased from 12 to 20 percent between 1982 and 1988 (Table 1). The condom, however, is sometimes used in combination with other methods—often, the pill. Women who use the pill, sterilization, or the IUD (intrauterine device) along with the condom are not classified in the statistics cited above, and in Table 1, as using the condom, but as using the other method, because the other is more effective in *preventing pregnancy*.[2] If we count all women who reported that their partners use condoms for birth control in 1988, even if they are using some other birth control method (such as the pill), we get an estimate of about 5.8 million women ages 15–44 whose partners were currently using the condom[1]—about 10 percent of the 58 million women of reproductive age.

The IUD and Female Sterilization

In 1985 and 1986, the IUD was withdrawn from the US market by two of its major manufacturers.[3] As a result, use of the IUD dropped by two-thirds between 1982 and 1988, from 2.2 million women in 1982 to 0.7 million in 1988.

TABLE 1—Number of Women 15–44 Years of Age, Percent and Number Using Contraception, and Percent Distribution by Method Used, According to Marital Status: US, 1982 and 1988

	Total		Never married		Currently married		Formerly married	
	1982	1988	1982	1988	1982	1988	1982	1988
Number of women (thousands)	54,099	57,900	19,164	21,058	28,231	29,147	6,704	7,695
Percent using contraception	55.7	60.3	35.3	41.9	69.7	74.3	55.5	57.6
Number using contraception (thousands)	30,133	34,914	6,765	8,823	19,677	21,656	3,721	4,432
All contraceptors	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Female sterilization	23.2	27.5	3.7	6.4	26.9	31.4	39.2	50.7
Male sterilization	10.9	11.7	1.8	1.8	15.5	17.3	3.4	3.6
Pill	28.0	30.7	53.0	59.0	19.3	20.4	28.4	25.3
IUD	7.1	2.0	5.4	1.3	6.9	2.0	11.5	3.6
Diaphragm	8.1	5.7	13.4	4.9	6.5	6.2	6.7	5.3
Condom	12.0	14.6	11.6	19.6	14.1	14.3	1.5	5.9
Other	10.7	7.7	11.1	7.0	10.8	8.4	9.2	5.7

SOURCE: Reference 1.

Address reprint requests to William D. Mosher, PhD, Room 840, National Center for Health Statistics, 6525 Belcrest Road, Hyattsville, MD 20782

Groups that had relatively high proportions using the IUD in 1982 tended to increase their use of female sterilization by 1988. For example, the percent of formerly married contraceptive users who were using the IUD fell from 12 percent in 1982 to 4 percent in 1988, and the percent using female sterilization rose from 39 percent to 51 percent. The new report and a forthcoming analysis show a sharp increase in the percent of contraceptive users who chose female sterilization among several groups that had higher than average proportions using the IUD in 1982: Black, formerly married, less educated, low income, and Hispanic women.[1,4]

Why has female sterilization become the leading method among married and formerly married women? Previous studies of NSFG data have shown that by age 30, three-forths of ever married women have had all the births they want; a typical woman getting a tubal operation was about age 30 and had two or three births. This means that she had 10 or 15 years remaining when she might be able, but did not want, to conceive. About five out of six women in their late 20s have used the pill, which probably means that they want contraception that is as effective and as unobtrusive as the pill. Now that the IUD is no longer widely available, there are only two methods as effective as the pill: female sterilization and male sterilization. The medical techniques of female sterilization have become markedly easier and safer in the past 20 years, so that sterilization often does not require an overnight hospital stay. Also, insurance coverage of sterilization may have become more common in recent years.[4,5]

The Pill

The pill was introduced in the United States 30 years ago, in 1960. Since then, it has been used by the vast majority of women of reproductive age—40.3 million women ages 15–44 in 1988 have used the pill at some time in their lives; 10.7 million of them were using it in 1988. Among women under age 25, the pill was by far the leading method in both 1982 and 1988. The sharp decline in pill use that occurred among married women between 1973 and 1982 did not continue between 1982 and 1988.[1]

Use of Family Planning Services

Sterilization, the pill, and the diaphragm account for 76 percent of current contraceptive use. All of these methods require medical visits to obtain them initially; use of the pill requires regular visits to renew the prescription and check for side effects. Previous research has shown that pill users have a particularly high rate of use of family planning services, even after their other characterizations are taken into account.[6] In addition, young women often make family planning visits to obtain pregnancy tests or to learn about birth control methods.[7] For these reasons and others, it is important to determine how many women use family planning services, and where they obtain those services.

About 20 million women (35 percent of the 57.9 million women ages 15–44) made one or more visits for family planning services in the 12 months before the survey.[8] This was about the same number as in the 12 months before the 1982 survey. Of the 20 million women, about 13 million obtained these services from a private physician, private group practice, or health maintenance organization (HMO); about 7 million used a clinic. Of the 7 million clinic users, about half, or 3.74 million, used a Title X clinic. Black women, teenagers, and low-income were much more likely to use clinics than other women. Women were also more likely to use clinics for their first visit than for their most recent visit: 58 percent used a clinic at their first visit, while only 36 percent used a clinic at their most recent visit. The age group most likely to have had a family planning visit in the last year was women 20–24 years of age—the age group in which use of the oral contraceptive pill is most common.[4,8]

These are only some of the first findings from the 1988 National Survey of Family Growth. Other reports are planned on such topics as contraception, infertility, marriage and cohabitation, and wanted and unwanted births. In addition, a public use computer tape of the 1988 data has been released, so that interested researchers can explore these and other topics further.

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Copies of *Contraceptive Use in the United States, 1973–88*, Advance Data from Vital and Health Statistics No. 182, and *Use of Family Planning Services in the United States: 1982 and 1988*, Advance Data from Vital and Health Statistics No. 184 can be obtained free of charge from the Scientific and Technical Information Branch, Room 1064, NCHS, 6525 Belcrest Road, Hyattsville, MD 20782.

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